DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1922

WITH

APPENDIXES

HENRY O'MALLEY
Commissioner

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

CONTENTS.

ERRATA.

APPENDIX I.—Page 29, 2d paragraph, 2d line: Superior reference figure *3* should read 7.

APPENDIX II.—Page 17, 4th line from top: *lever* should read *liver.* Page 18, 3d line from bottom: *solor* should read *solar.*

APPENDIX IV.—Page 13, last paragraph: 3d line, *1890a* should read *18906a;* 4th line, *1890e* should read *18905e;* 5th line, *1881g* should read *18816g.* Page 49, 7th line from top: *line* should read *fine.* Page 52, footnote: after ***which*** insert *one.*

APPENDIX VII.—Page 1, right-hand column of Contents: 4th line, ***blank space*** should be *11;* 5th line, *11* should be *12.*

APPENDIX VIII.—Page 69, 3d line from top: *favorable* should read *favorably.* Page 101: *Verril* reference under Argentina should be transposed to page 105 to become the 3d reference under Miscellaneous. Page 103, 4th line from bottom: *Estvada* should read *Estrada.* Page 105, 1st line under Uruguay: *Anonymous* should read *Dawson, William.*

APPENDIX XVI.—Page 18, little below center of page: ***1920 census*** should read ***1916 census.***

REPORT OF THE UNITED STATES COMMISSIONER OF FISHERIES FOR THE FISCAL YEAR ENDED JUNE 30, 1922

DEPARTMENT OF COMMERCE.

BUREAU OF FISHERIES.

HEADQUARTERS STAFF, 1921-22.

Commissioner,

HENRY O'MALLEY.

Deputy Commissioner.—H. F. MOORE.
Assistants in Charge of Divisions:
Office.—IRVING H. DUNLAP.
Fish Culture.—GLEN C. LEACH.
Inquiry Respecting Food Fishes.—ROBERT E. COKER.
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Alaska Service.—WARD T. BOWER.
Architect and Engineer.—GEORGE A. SCHNEIDER.
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Superintendent Central Station and Aquaria.—L. G. HARRON.

Bureau of Fisheries Document No. 913.

CONTENTS.

REPORT

OF THE

COMMISSIONER OF FISHERIES.

Department of Commerce,
Bureau of Fisheries,
Washington, September 15, 1922.

Sir: I have the honor to submit herewith a report of the operations of the Bureau of Fisheries during the fiscal year ended June 30, 1922.

FISHERY INDUSTRIES SERVICES.

REVIEW.

The period of extreme depression that affected the fisheries and fishery industries following the Great War appears to have passed, and indications of slow but gradual improvement are apparent. This change was little in evidence in 1921, the catch and the quantities preserved by various means generally being smaller than in 1920. For example, in the vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., the landings of fresh and salted fish in 1921 amounted to 150,865,106 pounds, valued at $5,722,629, a decrease of 27,415,595 pounds in quantity and of $2,504,384 in value as compared with the previous year. In Alaska, the pack of canned salmon amounted to 2,596,826 cases, valued at $19, 632,744, a decrease of 1,832,637 cases in quantity and of $15,970,056 in value as compared with 1920. The pack of sardines in Maine in 1921, amounting to 1,350,631 cases, valued at $3,960,916, represents a decrease from the previous year of 527,126 cases in quantity and of $3,474,140 in value. In California the total catch of all fishery products amounted to 127,728,623 pounds, a decrease of nearly 85,000,000 pounds as compared with 1920. The prices received for the products have materially declined, as indicated by the statistics given and as illustrated by the conditions obtaining in the vessel fisheries of the three New England ports mentioned. In 1916 the average price per pound received for these fish ex-vessel was 3.44 cents; in 1918, 5.12 cents; in 1921, 3.79 cents; and for the period January to June, 1922, inclusive, 3.26 cents. Reports emanating from European countries that have important fisheries indicate that their fisheries have been even more severely affected than our own.

While specific statistical data are not available for all lines for 1922, operations generally reflect a firmer tone in the market and canners and manufacturers of scrap and oil are proceeding with

considerable more assurance than during the preceding year. Reductions in transportation rates also have an important bearing on the situation.

The bureau has endeavored to render the industry all possible aid in coping with the difficulties encountered during this period, particularly along practical lines in merchandising and preservation of fishery products. Its trained personnel has given freely of its time in supplying suggestions and advice to those in the industry and in collecting for their use needful information covering practically every phase of the fishing industry. Its activities have included a series of highly valued market surveys of the following centers: Louisville, Ky., Pittsburgh, Pa., Chicago, Ill., Minneapolis and St. Paul, Minn., and Seattle, Wash. In the field of statistics, canvasses have been made of the fisheries of Maryland and Virginia for 1920, including the catch of shad and alewives in those States in 1921, and of the canning and by-products industries of the United States and Alaska in 1921, in addition to those of the landings of the vessel fisheries at the ports of Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., and statistical bulletins of cold-storage holdings of frozen fish have been issued monthly, beginning with the returns for January 15, 1922.

Fisheries technological investigations have included comprehensive investigations in net preservation, studies of refrigeration, including the freezing of fish in brine, and scientific studies of the principles involved in the processes of canning such fish as sardines.

FISH MERCHANDISING.

The field of fish merchandising affords many opportunities for helpful service to which the bureau is giving a larger measure of attention. The need for such service is reflected in the low per capita consumption of fish in this country, in the difficulties encountered by the producers in finding outlets for their catch of fish with existing equipment of capture, and in the low prices received by them for the products of their labor. The producers are fully aware of the need of effecting improvements in the distribution of fresh and frozen fish as indicated by the interest shown in precooling of fish in brine, and in preparing the fish for the convenience of the housewife, as by filleting and by wrapping the individual fish in parchment paper.

MARKET SURVEYS.

Market surveys of certain large distributing centers for fresh and frozen fish, initiated in June, 1921, at Louisville, Ky., were continued through the greater part of the year by surveys of Pittsburgh, Pa., Chicago, Ill., Minneapolis and St. Paul, Minn., and Seattle, Wash., the results of which have been published as Economic Circulars Nos. 52, 54, 55, and Document No. 930, respectively.

The supply of fresh and frozen fishery products reaching Pittsburgh, Pa., is derived chiefly from the Great Lakes, the west coast from Seattle to Prince Rupert, and the Atlantic coast from New York to Boston. Halibut from the Pacific coast is the most important single species sold in Pittsburgh. Other species of importance, which with halibut constitute about 75 per cent of the

trade, are blue pike, ciscoes, cod, sauger, whitefish, yellow pike, and shucked oysters. At the time the survey was made 71 firms were engaged in the fish business. Five of the firms were in the wholesale trade exclusively and six in both the wholesale and retail trades. In the retail stores ice was used in conjunction with all displays, of which 86 per cent were made in inclosed cases covered with glass or other protective materials.

The bulk of Chicago's supply of fresh and frozen fish is derived from the Great Lakes, the North Pacific coast, and lakes in the Dominion of Canada. During the year ended July 31, 1921, 526 carloads of fresh and frozen fish, exclusive of oysters, were received from the Dominion of Canada, as compared with 272 from the United States. During the same period 195 carloads of oysters were received and 422 express carloads of fish passing through Chicago from northern and western points, consigned to points in the East and South, were opened and partially unloaded en route by local dealers. Of the 81 different species marketed in Chicago approximately 70 per cent of the trade is confined to but 11, namely, buffalofish, carp, ciscoes, whitefish, lake trout, salmon, pike or "jacks," yellow perch, "yellow pike" (pike perch), halibut, and shucked oysters. The fishery products are handled either exclusively or as major commodities, compared with other foods, by 222 Chicago firms, of which 56 are in the wholesale business exclusively. In addition there are several thousand butcher, grocery, and delicatessen stores that handle fish as a side line on Fridays.

Minneapolis and St. Paul receive their supplies of fish mainly from lakes in the Canadian Provinces of Manitoba and Alberta, Lake Superior, near-by rivers and small lakes, and the North Pacific coast from Seattle to Prince Rupert. About 90 per cent of the sales of fresh and frozen fishery products consists of "yellow pike" or pike perch, halibut, salmon, lake trout, whitefish, ciscoes or "lake herring," and shucked oysters. During the year ended September 30, 1921, 5,142,783 pounds of frozen fish, of which 3,629,713 pounds are credited to Minneapolis, were placed in public cold-storage warehouses in these two cities.

As a distributing center for fresh and frozen fishery products Seattle is the most important on the Pacific coast and as a fishing port is exceeded in the United States only by Boston and Gloucester, Mass. The quantity of fresh and frozen fish received during 1921 amounted to over 45,000,000 pounds, of which 63 per cent was reshipped in the fresh or frozen condition for consumption in other cities. Of the carload shipments 92 per cent was consigned to points east of Omaha, Nebr., and less-than-carload shipments were confined largely to cities west of Omaha. Salmon and halibut constitute the backbone of the trade, the combined landings of these two species during 1921 constituting over 83 per cent of all fresh and frozen fishery products reaching this market. Fishing areas off the coast of Oregon, Washington, British Columbia, and Alaska, together with Puget Sound, constitute the principal areas of supply. Fish-freezing establishments located in Seattle froze in excess of 12,000,000 pounds of fish during 1921 and received over 2,000,000 pounds already frozen. Withdrawals during this period amounted to 14,077,007 pounds, of which 6,209,562 pounds were halibut and 6,137,484 pounds salmon.

TECHNOLOGICAL INVESTIGATIONS.

Such important investigations as have been undertaken in this field are of necessity time consuming and require a considerable investment. It has been the policy of the bureau to center its activities on a limited number of such problems that promise important benefits to the greatest possible number in the industry when brought to a successful end. To make satisfactory progress in these fields of endeavor with the limited personnel and funds available necessitates close adherence to this program and avoidance wherever practicable of undertaking minor investigations for which there may be some demand. The bureau regrets the necessity of making such limitations, but deems it the wiser course to pursue under present handicaps. The major technological investigations in progress are in the fields of net preservation, canning, and refrigeration, including freezing in brine.

PRESERVATION OF FISHING NETS AND LINES.

During the year excellent progress has been made in the investigation on the preservation of nets, including tests of the value of various net preservatives, increase in weight of the net by the addition of the various preservatives, shrinkage, breaking strength, wearing quality, relative stiffness of lines when treated with the various preservatives in comparison with the untreated line, etc. Attention has also been given to the development of an improved preservative for nets. A large series of lines has been placed in the water at a number of places for protracted periods, sets being taken up and subjected to various tests at regular intervals. Such investigations will be completed in the near future, and a report on the results thus far attained will be prepared for the use of the trade as promptly as practicable.

CANNING OF FISHERY PRODUCTS.

A study of the changes that take place in the oil used for frying sardines, conducted at San Pedro, Calif., has been concluded and the results published.[1]

In view of certain difficulties attending the frying of sardines in oil, it was deemed advisable to attempt to develop a method of packing that would eliminate the use of the fry bath and that might be economically employed by such as wished to change their process. Work along these lines is being continued. The preparation of sardines for canning is largely a problem of removing excess water from the fish. Frying in oil, steaming, and cooling in brine, are aids to the accomplishment of this end. In the trials made, the best results accrued from removing the excess water by thorough brining and drying, followed by packing the fish raw and depending upon subsequent processing to cook them. From an economic point of view the process appears to possess some merit. Storage and shipping tests are in progress.

[1] Changes in Oil Used for Frying Sardines, by Harry R. Beard, State of California Fish and Game Commission Circular No. 1, March, 1922, Sacramento, Calif.

FREEZING OF FISH IN BRINE.

The possibilities of freezing fish in brine continue to attract much attention, both in this country and abroad. To meet demand the bureau has issued an economic circular giving a review of the subject. This report calls attention to means of properly glazing fish frozen in brine and stresses the point that the most important aspect of brine freezing awaiting development is its practical application on a large scale.

BRAZILIAN INTERNATIONAL CENTENNIAL EXPOSITION.

According to a joint resolution of Congress accepting the invitation of the Republic of Brazil to take part in an international exposition to be held in Rio de Janeiro in 1922, the Secretary of Commerce is "authorized to collect and prepare a suitable exhibit of the fisheries industry of the United States for exhibit at the said exposition and accompany the same with a report respecting such industry, to be printed in the English, Spanish, and Portuguese languages." As the United States commission to the exposition allotted but 900 square feet of floor space and less than $5,000 for the assembling of the exhibit in Washington, D. C., the exhibit has of necessity been small. It is educational in character, showing the relationship of the Federal Government to the fisheries, the diversity and character of our fisheries and fishery products, possibilities of American markets as a source of raw materials required in the fishing industry, and opportunities for acquiring industrial education afforded those who may wish to specialize in this field. The exhibit includes displays representing the New England offshore fisheries, the salmon industry, the sardine industry of Maine and California, the oyster industry, the fresh-water mussel industry, the fish-canning industry, by-products of the fisheries, and an illustrated story of the bureau's organization and activities. The report deals with the fisheries of the United States, the organization and functions of the bureau, and the opportunities afforded students of fisheries in the United States to acquire industrial education in this field. The bureau is allowed but a single representative at the exposition, which is scheduled to open September 7, 1922, and close March 31, 1923.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS.

The bureau has made a canvass of the canned fishery products and fishery by-products industries of the United States and Alaska for the year 1921. The total value of the fishery products canned during the year was $46,634,706, and the value of the fishery by-products prepared, such as fish oil, fertilizer, liquid glue, poultry grit, and lime, was $8,351,827. The results of the canvass were published and distributed to the trade as Statistical Bulletin No. 526.

The pack of canned salmon, reduced to the equivalent of 48 pounds of fish to the case, amounted to 3,599,774 cases, valued at $28,867,169, of which 2,596,826 cases, valued at $19,632,744, were packed in Alaska, and 1,002,948 cases, valued at $9,234,425, in the Pacific Coast States. Other canned-salmon products, valued at $69,170, were also prepared.

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The pack of sardines in Maine in 1921 amounted to 1,350,631 cases, valued at $3,960,916, compared with 2,450,268 cases, valued at $11,933,986, in 1919, and 1,877,757 cases, valued at $7,435,056, in 1920. The pack of sardines in California in 1921 was 415,587 cases, valued at $2,346,446, compared with 1,150,616 cases reported for 1919, and 1,062,996 cases reported for 1920.

The canning of shad is confined to the States of Oregon and Washington. The pack of shad in 1921 amounted to 841 cases, valued at $2,455, and of shad roe to 53 cases, valued at $142. These products are packed in half-pound flat, half-pound oval, and 1-pound tall cans with 48 cans to a case.

The pack of canned alewives and alewife roe in 1921 was prepared in Maryland, Virginia, and North Carolina. The pack of alewives amounted to 312 cases, or 8,976 cans, valued at $813; and of roe to 40,530 cases, or 1,197,288 cans, valued at $157,841.

The pack of canned albacore in California in 1921 amounted to 344,117 cases, valued at $2,657.266; the pack of canned tuna to 74,704 cases, valued at $416,415; and of canned mackerel to 2,255 cases, valued at $12,275; a total of 421,076 cases, valued at $3,085,956. These products were packed in cans of various sizes with 48 cans to a case.

In 1921 shrimp were canned in Louisiana, Mississippi, Alabama, Florida, Georgia, and North Carolina, the pack amounting to 667,558 cases, with a value of $3,804,781. Louisiana led with a pack of 273,218 cases, valued at $1,530,072, or 40 per cent of the total value of the pack. Mississippi ranked second with 169,751 cases, valued at $958,268. The bulk of the pack is put up in No. 1 cans, four dozen to the case, representing 597,474 cases, valued at $3,407,977. Smaller quantities were packed in No. 1½ and No. 2½ cans, two dozen to the case, and No. 10 cans, one-half dozen to the case.

Crabs were canned at two plants in Virginia, two in Alaska, and one each in Washington and Louisiana, the pack amounting to 11,960 cases, valued at $115,800.

In 1921 the pack of razor clams, confined to Oregon, Washington, and Alaska, amounted to 92,085 cases, valued at $509,122, and included whole and minced clams and clam juice. The pack of hard clams, confined to Florida and Washington, amounted to 46,207 cases, valued at $212,846, and included whole and minced clams, clam bouillon, chowder, and juice. The pack of soft clams, confined to Maine and Massachusetts, amounted to 87,838 cases, valued at $444,539, which included whole clams, clam bouillon, chowder, and extract. The total pack of clams produced was 226,130 cases, with a value of $1,166,507.

In 1921 oysters were canned in Maryland, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana, the pack amounting to 455,550 cases, valued at $2,179,271. Maryland outranked the other States with a pack of 156,431 cases, valued at $778,435, Mississippi being second with a pack of 143,938 cases, valued at $699,405.

In 1921 there were 39 factories engaged in the reduction of menhaden, utilizing 1,031,540,831 fish, or 618,924,499 pounds, valued at $1,929,219. The yield of scrap and meal was 82.662 tons, valued at $2,286,095, and of oil, 6,260,478 gallons, valued at $1,719,892, the total value of the products amounting to $4,005,987.

The total production of fish oils in 1921 (including menhaden) in the United States and Alaska amounted to 7,446,281 gallons, valued at $2,078,670. The production of the various oils were as follows: Menhaden oil, 6,260,478 gallons; whale oil, 354,372 gallons; herring oil, 283,815 gallons; sperm oil, 168,729 gallons; salmon oil, 71,522 gallons; cod and cod-liver oil, 49,772 gallons; and miscellaneous fish oils, 257,593 gallons.

The production of fish (including menhaden) and whale scrap and meal and shrimp bran in 1921 amounted to 107,273 tons, valued at $3,557,142. The production of dried scrap and meal was 60,031 tons, valued at $2,613,361; of acidulated scrap, 44,454 tons, valued at $895,140; of crude or green scrap, 2,160 tons, valued at $31,827; and of shrimp bran, 628 tons, valued at $16,814. The production in the Atlantic and Gulf States amounted to 89,559 tons, and in the Pacific coast States and Alaska to 17,714 tons. Although it is impracticable to obtain definite figures as to the quantities of fish meal used for feeding purposes, it is evident that the demand for this commodity is rapidly increasing, particularly on the Atlantic seaboard.

In 1921 there were 54 plants engaged in grinding oyster shells for the production of poultry grit and lime, the yield of which amounted to 259,238 tons, valued at $2,261,754, of which 185,474 tons, valued at $1,759,120, were poultry grit.

Other by-products of the fisheries included fish glue, shark and porpoise hides, agar-agar, pearl or fish-scale essence, shark fins, whale bones (skeletons) and whale tails, to the value of $454,261.

FROZEN-FISH TRADE.

Statistics of the cold-storage holdings of frozen fish have been collected and published by the Bureau of Markets, Department of Agriculture, beginning with October, 1916. These reports give the holdings on the fifteenth day of the current month. Through the courtesy of that bureau arrangements were made in December, 1921, for the Bureau of Fisheries to publish and disseminate this information, beginning with the returns for January 15, 1922, in the form of a monthly statistical bulletin. This bulletin gives the holdings by species and sections, total holdings for the current month and for the same month of the previous year, the five-year average, holdings for the previous month, and the quantity of each species frozen during the month.

The quantity of fish frozen between December 15, 1920, and December 15, 1921, according to these statistics, was 79,173,892 pounds, as compared with 93,973,589 pounds the previous year. The principal species and quantities frozen during the year ended December 15, 1921, were halibut, 10,773,803 pounds; salmon, 10,033,619 pounds; herring, 9,827,671 pounds; ciscoes, 8,649,315 pounds; whiting, 5,527,047 pounds; and miscellaneous fishes, 14,436,657 pounds.

SMOKED-FISH INDUSTRY OF MAINE.

In 1921 there were 28 firms engaged in smoking fishery products in Maine, exclusive of a few individuals smoking small quantities of alewives, as compared with 50 firms in this industry in 1919. The

smoked products included 2,111,206 pounds of herring, valued at $189,653; 471,205 pounds of finnan haddie, valued at $67,105; and 42,333 pounds of alewives, valued at $2,925; a total of 2,624,744 pounds, valued at $259,683. Compared with 1919, there has been a decrease in the smoked-fish products prepared in the State of 41 per cent in quantity and 50 per cent in value.

NEW ENGLAND VESSEL FISHERIES.

The bureau, through its local agents, has collected detailed statistics of the vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., which have been published in monthly and annual statistical bulletins. Two annual bulletins have been issued, one showing the catch by months, the other by fishing grounds. There was a decrease in the number of trips and also in the quantity and value of the products landed at these ports during the year as compared with the previous year. At Portland there was a small increase in the number of trips and in the quantity of products landed, but a decrease in the value.

The fishing fleet at these ports during the calendar year 1921 numbered 398 sail, steam, and gasoline screw vessels, including 23 American and 3 Canadian steam trawlers. These vessels landed at Boston 3,078 trips, aggregating 104,368,629 pounds of fish, valued at $4,190,135; at Gloucester, 2,073 trips, aggregating 33,016,166 pounds, valued at $920,250; and at Portland 2,055 trips, aggregating 13,480,311 pounds, valued at $612,244. The total for the three ports amounted to 7,206 trips, aggregating 150,865,106 pounds of fresh and salted fish, having a value to the fishermen of $5,722,629.

The foregoing total includes 72 trips, 49 at Boston, 7 at Gloucester, and 16 at Portland, landed by 22 Canadian fishing vessels, amounting to 4,222,319 pounds of fish, valued at $127,549. Of this quantity, 1,849,702 pounds, valued at $65,388, were landed at Boston; 239,209 pounds, valued at $8,409, at Gloucester; and 2,133,408 pounds, valued at $53,752, at Portland. There was an increase of 4 vessels and 18 trips, and of 1,634,101 pounds in quantity and $8,521 in value of fish landed as compared with the previous year. These fish were landed in accordance with an arrangement with the Canadian Government as an emergency war measure granting reciprocal privileges to fishing vessels, by which Canadian fishing vessels were permitted to land their fares at American ports direct from the fishing grounds. Canadian vessels began to utilize this privilege in April, 1918, and the arrangement was canceled to take effect July 15, 1921, but a number of trips were admitted after that date, the last one being landed in September.

Compared with the previous year, there was a decrease of 400 trips, or 5.25 per cent, in the total number landed by the fishing fleet at Boston, Gloucester, and Portland, and of 27,415,595 pounds, or 15.37 per cent, in quantity and of $2,504,384, or 30.44 per cent, in the value of the products landed. The only important species showing an increase in both quantity and value was halibut. The catch of halibut increased 1,876,698 pounds, or 49.52 per cent, in quantity and $61,253, or 8.25 per cent, in value. The catch of cusk increased 243,676 pounds, or 13.13 per cent, in quantity but decreased $10,241,

or 21.30 per cent, in value. There was a decrease in both quantity and value of the catch of all the other more important species. The catch of cod decreased 8,750,568 pounds, or 14.05 per cent, in quantity and $906,870, or 34.38 per cent, in value; haddock, 7,866,768 pounds, or 10.45 per cent, in quantity and $693,882, or 25.32 per cent, in value; hake, 185,248 pounds, or 3.92 per cent, in quantity and $44,273, or 28.77 per cent, in value; pollock, 1,615,890 pounds, or 18.87 per cent, in quantity and $97,486, or 37.19 per cent, in value; mackerel, 3,909,-541 pounds, or 53.60 per cent, in quantity and $427,468, or 56.01 per cent, in value; herring, 4,384,444 pounds, or 62.65 per cent, in quantity and $125,894, or 75.70 per cent, in value; and swordfish, 934,024 pounds, or 36.89 per cent, in quantity and $175,796, or 35.57 per cent, in value. The catch of Newfoundland herring declined from 3,097,-024 pounds, valued at $110,157, in 1920, to 551,400 pounds, valued at $19,584, in 1921. In the various other species combined there was a decrease of $1,889,486 pounds, or 37.89 per cent, in quantity and of $83,727, or 38.08 per cent, in value.

The catch of cod, haddock, and hake is sold in different grades as landed from the vessels. Cod are sold as large, market, and scrod; haddock, as large and scrod; and hake, as large and small. The quantity of scrod cod and scrod haddock is very small as compared with that of the other grades of these species, said to be due to the fact that the price received is so low that the fishermen do not save all that are caught. The catch of scrod cod landed at these ports during the year was 1,150,577 pounds, valued at $10,844, and of scrod haddock only 30,562 pounds, valued at $535.

The fishery products landed at Boston, Gloucester, and Portland by fishing vessels each year are taken principally from fishing grounds off the coast of the United States. In the calendar year 1921, 85.39 per cent of the quantity and 77.99 per cent of the value of the catch landed by American and Canadian fishing vessels at these ports were from these grounds; 4.08 per cent of the quantity and 7.32 per cent of the value, consisting chiefly of cod, halibut, and herring, were from fishing banks off the coast of Newfoundland; and 10.51 per cent of the quantity and 14.67 per cent of the value from fishing grounds off the Canadian Provinces. There was considerable falling off in the percentage of products from grounds off the Canadian Provinces, but an increase in that from grounds off the United States and Newfoundland compared with the previous year. Newfoundland herring constituted less than one-half of 1 per cent of the quantity and value of the fishery products landed at these ports during the year. The herring were taken from the treaty coast of Newfoundland, and the cod, haddock, hake, halibut, and other species from that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds.

Haddock ranked first in both quality and value in the vessel fisheries at these ports in 1921, the catch amounting to 67,412,709 pounds, valued at $2,046,170, all landed fresh except 15,290 pounds salted, valued at $182. The catch of cod was 53,515,014 pounds, valued at $1,730,767, including 5,408,768 pounds salted, valued at $217,310. The catch of hake was 4,536,108 pounds, valued at $109,603, all landed fresh except 42,233 pounds salted, valued at

$765. More than half of the catch was landed at Boston. The catch of pollock amounted to 6,945,011 pounds, valued at $164,642, all landed fresh except 51,992 pounds salted, valued at $913. The catch of cusk was 2,098,415 pounds, valued at $37,829, all landed fresh except 38,433 pounds salted, valued at $781. The catch of halibut was 5,666,028 pounds, valued at $803,074, all landed fresh except 48,431 pounds salted, valued at $7,076. There was an increase in the halibut catch of 1,876,698 pounds in quantity and $61,253 in value as compared with the previous year. The catch was the largest taken in the past six years. The quantity landed at Boston was 3,808,468 pounds, valued at $556,592; at Gloucester, 433,361 pounds, valued at $46,510; and at Portland, 1,424,199 pounds, valued at $199,972. The catch of swordfish was 1,597,645 pounds, valued at $318,406; and of flounders, 2,604,657 pounds, valued at $111,956. The catch of herring amounted to 2,613,540 pounds, valued at $40,407. Of this quantity, 2,062,140 pounds, valued at $20,823, were taken off the coast of the United States and landed fresh; and the remainder, including 200,000 pounds fresh, frozen, valued at $10,000, and 351,400 pounds salted, valued at $9,584, were Newfoundland herring.

The total catch of fresh mackerel taken by the American fishing fleet in 1921 was 40,323 barrels, compared with 79,799 barrels in 1920, a decrease of 39,476 barrels. The total catch of salted mackerel was 3,242 barrels, compared with 4,897 barrels in 1920, a decrease of 1,655 barrels. The quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet in 1921 was 3,384,180 pounds, valued at $335,626, of which 2,734,680 pounds, valued at $290,164, were fresh, and 649,500 pounds, valued at $45,462, were salted.

In 1922 the total catch of mackerel up to July 1 was 25,000 barrels fresh and 2,344 barrels salted, compared with 33,632 barrels fresh and 3,143 barrels salted for the same period in 1921. In the southern mackerel fishery both the purse-seine vessels and the gill-net vessels had a poor season. The weather was favorable for fishing, but the mackerel were not abundant. The fish landed were practically all of large and medium size and sold from 9 to 30 cents per pound, according to market conditions. The first mackerel landed sold at 60 cents per pound. The southern mackerel fleet was about the same size as in the previous year. The Cape Shore fleet was larger than last year but less successful. The first arrival was on May 25 and consisted of large and medium fish, which sold at 18.6 cents per pound. On June 2, fresh mackerel sold at 6¼ cents per pound from the vessel, the lowest price since 1919. Cape Shore salted mackerel sold from $12 to $13 per barrel.

VESSEL FISHERIES AT SEATTLE, WASH.

Statistics of the vessel fisheries at Seattle, Wash., have been collected by the local agent and published as monthly and annual statistical bulletins, giving the quantity and value of fishery products landed by American fishing and collecting vessels during the year at that port.

The fishing fleet at Seattle, in 1921, landed 866 trips, amounting to 13,666,700 pounds of fish, having a value to the fishermen of $1,423,303, from fishing grounds along the coast from Oregon to Portlock

Bank, Alaska. The largest quantities were taken from Flattery Banks, west coast of Vancouver Island, and Hecate Strait. The products included halibut, 11,481,000 pounds, valued at $1,335,658; sablefish, 1,519,400 pounds, valued at $63,685; "lingcod," 463,300 pounds, valued at $16,391; and rockfishes, 203,000 pounds, valued at $7,569. Compared with the previous year there was an increase of 44 trips by fishing vessels, but a decrease of 688,750 pounds, or 4.79 per cent, in the quantity and of $569,456, or 28.57 per cent, in the value of the products. There was a decrease in the catch of halibut of 1,202,450 pounds, or 9.48 per cent, in quantity and of $578,191, or 30.21 per cent, in value. The catch of "lingcod" decreased 49,735 pounds, or 9.69 per cent, in quantity and $4,762, or 22.51 per cent, in value; and the catch of rockfishes decreased 5,765 pounds, or 2.76 per cent, in quantity and $225, or 2.88 per cent, in value. There was an increase in the catch of sablefish of 569,200 pounds, or 59.90 per cent, in quantity and of $13,722, or 27.46 per cent, in value.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 12,428,525 pounds, valued at $778,878. This quantity included 10,349,700 pounds of salmon, valued at $679,171, and the remainder consisted of herring, steelhead trout, smelt, perch, rockfishes, "lingcod," flounders, sole, and crabs. Compared with the previous year, there was an increase in the products landed by collecting vessels of 2,614,559 pounds, or 26.64 per cent, in quantity, but a decrease of $102,188, or 11.59 per cent, in value.

FISHERIES OF CALIFORNIA.

Through the courtesy of the California Fish and Game Commission, the bureau has received statistics of the catch of fish taken in the waters of that State by species and localities for the calendar year 1921. The catch taken during the year amounted to 127,728,623 pounds, as compared with 212,635,075 pounds the previous year, a decrease of 84,906,452 pounds, or 39.93 per cent. The principal species were pilchards, 59,332,305 pounds; albacore and tuna, 19,831,680 pounds; flounders, 8,429,595 pounds; salmon, 7,990,932 pounds; rockfishes, 4,641,156 pounds; barracuda, 4,588,900 pounds; mackerel, 2,914,613 pounds; yellowtail, 2,139,626 pounds; white sea bass or squeteague, 2,069,544 pounds; anchovies, 1,946,881 pounds; abalones, 1,481,170 pounds; bonito or skipjack, 1,376,712 pounds; sablefish, 1,022,556 pounds; and shad, 862,897 pounds. Compared with 1920, the catch of pilchards decreased 59,185,424 pounds, or 49.93 per cent; albacore and tuna, 16,312,660 pounds, or 45.13 per cent; and bonito or skipjack, 7,237,869 pounds, or 84 per cent. There was an increase in the catch of anchovies of 1,376,195 pounds, or 241.15 per cent, and in the catch of sablefish of 241,524 pounds or 30.92 per cent.

The imports of fresh fish from Mexico in 1921 amounted to 6,699,817 pounds, as compared with 8,121,225 pounds the previous year. The principal species imported were barracuda, 3,036,262 pounds; flounders, 1,314.918 pounds; sea crawfish or spiny lobster, 943,547 pounds; and white sea bass or squeteague, 500,075 pounds.

FISHERIES OF MARYLAND AND VIRGINIA.

A canvass of the fisheries of Maryland and Virginia for the calendar year 1920 was completed the latter part of 1921, and the results

were published in condensed form as Statistical Bulletin No. 520 early in 1922, and distributed to the trade.

The number of persons engaged in the fisheries of Maryland was 21,383, the investment was $7,566,434, and the products amounted to 59,530,795 pounds, with a value to the fishermen of $4,198,668. The principal species were oysters, 4,547,471 bushels, or 31,832,297 pounds, exclusive of shells, valued at $2,291,120; crabs, 27,188,922 in number, or 9,062,974 pounds, valued at $742,944; shad, 1,867,196 pounds, valued at $355,217; striped bass, 1,040,274 pounds, valued at $193,295; alewives, fresh and salted, 7,073,688 pounds, valued at $177,240; squeteague or "sea trout," fresh and salted, 2,281,490 pounds, valued at $92,284; and croaker, 2,519,770 pounds, valued at $66,576. Compared with 1904 there was a decrease of 8,954, or 29.51 per cent, in the number of persons employed and of 21,598,071 pounds, or 26.62 per cent, in the quantity of the products, with an increase of $862,108, or 25.83 per cent, in their value. There was also an increase of $1,582,969, or 26.45 per cent, in the investment.

The number of persons engaged in the fisheries of Virginia was 19,378, the investment was $10,709,499, and the products amounted to 471,219,089 pounds, having a value to the fishermen of $8,541,724. The principal species were oysters, 3,963,569 bushels, or 27,744,983 pounds, exclusive of shells, valued at $2,349,161; menhaden, 366,379,-425 pounds, valued at $2,158,518; shad, 7,293,805 pounds, valued at $1,145,106; squeteague or "sea trout," 12,908,502 pounds, valued at $654,521; crabs, 40,911,237 in number, or 13,637,079 pounds, valued at $565,564; croaker, 16,372,134 pounds, valued at $513,975; alewives, fresh and salted, 16,665,100 pounds, valued at $259,258; clams, 449,440 pounds, exclusive of shells, valued at $229,645; and butterfish, 3,018,842 pounds, valued at $136,894. Compared with 1904, there was a decrease of 9,490, or 32.87 per cent, in the number of persons employed, but an increase of $6,094,565, or 132.06 per cent, in the investment, of 115,903,291 pounds, or 32.61 per cent, in the quantity, and of $2,957,370, or 52.95 per cent, in the value of the products.

SHAD AND ALEWIFE FISHERIES OF THE POTOMAC RIVER.

The shad and alewife fisheries of the Potomac River in 1921 were engaged in by 983 fishermen. The number of boats used was 623, valued at $77,150. The fishing apparatus included 266 pound nets, valued at $87,295; 296 gill nets, valued at $37,565; and 6 seines, valued at $1,540. The shore and accessory property was valued at $7,735, and the total investment amounted to $214,885.

The number of shad taken was 405,872, or 1,160,438 pounds, valued at $207,370, of which 49,681, or 138,207 pounds, valued at $25,191, are credited to Maryland and 356,191 shad, or 1,022,231 pounds, valued at $182,179, to Virginia. Compared with 1920 there was a falling off in the catch of 123,486 shad, or 819,342 pounds, in quantity and of $127,094 in value.

The catch of alewives, or river herring, was 10,303,510 fish, or 4,121,404 pounds, valued at $44,041, of which 1,395,000 fish, or 558,000 pounds, valued at $9,010, are credited to Maryland and 8,908,510 fish, or 3,563,404 pounds, valued at $35,031, to Virginia.

FLORIDA SPONGE FISHERY.

The quantity of sponges sold at the Sponge Exchange, Tarpon Springs, Fla., in 1921, was 386,390 pounds, valued at $540,093. This total included large wool sponges, 173,723 pounds, valued at $463,170; small wool, 63,786 pounds, valued at $28,705; yellow, 70,218 pounds, valued at $30,428; grass, 65,745 pounds, valued at $12,823; and wire, 12,918 pounds, valued at $5,167. The prices of small wool sponges were so low the latter part of 1920 that several thousand bunches were held over for sale in 1921. For this reason the quantity of small wool sponges for 1921 was larger than for the previous year. It is estimated that $40,000 worth of sponges were sold at Tarpon Springs outside of the exchange. In addition an unknown but comparatively small quantity was sold at Key West.

INQUIRY RESPECTING FOOD FISHES AND FISHING GROUNDS.

INTRODUCTION.

It is an original and fundamental function of the bureau to inquire into the causes of the decrease of food fish and other useful resources of the waters, in order to seek means of checking decreases where they appear and of promoting increases wherever possible. Decreases of aquatic resources have occurred and are likely to continue with the increased demand upon the fish-food supply and with a growing population that steadily augments the number of possible fishermen and sportsmen.

There is indeed a conspicuous contrast between the histories of production of land and water products, respectively. While over a span of years we see with gratification a steady and noteworthy development in the yields of principal products of the land, we observe at the same time and, unfortunately, with generally small concern, an entirely different trend with regard to the crops that are derived from our waters. While we grow more wheat and corn, more cattle and poultry, we have less halibut and whitefish and fewer crabs and lobsters. New regions have been opened to production of potatoes and fruits, while considerable areas of water bottom, once productive of oysters, have become barren and sturgeon and other useful fishes disappear. Many of our fisheries bid fair to become merely historical records.

It is notable, too, that when a serious diminution in land crops threatens there is almost invariably a prompt and compelling demand for the application of methods of scientific research to the study of causes and remedies. Appropriations and personnel are made available so that serious losses may not continue indefinitely for lack of the services of skilled investigators or for want of proper equipment for attack upon the problems involved. On the other hand, the disappearance of useful aquatic resources has rarely awakened an effective public interest, and only a small and frequently changing personnel with very limited equipment is permitted to confront the complicated problems that concern a hundred different resources of seas, lakes, and rivers. While a diminution in the yield of corn becomes a

cause for action, a decline in production of shad remains a topic for conversation.

This is not to say that the exhaustion of fishery resources is inevitable or that the decline of fisheries has not in some instances been arrested or retarded. In many cases, though not in all, effective results have been gained by the application of measures of production and propagation as far as has been permitted by the knowledge available and by the public will. Investigations pursued in the past have yielded a certain fund of knowledge regarding propagation, habits, and conditions of life of fishes, and upon such knowledge is based both the fish-culture work that is so extensively pursued in the United States and the great body of sound protective measures whenever in effect. Were the fund of knowledge greater, artificial propagation would be more successful and economical and would no doubt be effectively extended to other species, while protective legislation would be more wisely framed and more successful in the accomplishment of its purpose.

Never, perhaps, has there been greater demand for the application of knowledge regarding fishes to practical ends for the public good, while yet there is no proportionate demand for the discovery of the knowledge that can be given application.

During the past year the bureau has endeavored to apply its limited resources to the problems of the fishes in the most effective manner, having regard, inevitably, to the qualifications and experience of its available personnel and to the limited funds and equipment. The story of the progress and accomplishments in biological investigations is told in the following pages.

STUDIES OF FISHES.

Extensive studies were conducted of the runs of salmon in Alaska to determine the facts necessary for effective regulation of the fisheries, to the end that they may be maintained and improved. An important feature of this work is the determination of the proportion of the runs that must be permitted to escape to the spawning grounds in order that the natural increase may compensate for the fish captured before spawning. The bureau has accumulated some information on this subject in connection with its fish-cultural operations at Baker Lake and Quinault Lake, Wash., but conditions vary with the locality, and before the results can be generally applicable in a practical way it will be necessary to make careful studies in a number of streams presenting diverse physical conditions. During the year a rack was established in Karluk River, on Kodiak Island, and careful check was kept of the number of salmon passing to the spawning grounds after escaping the fishery conducted entirely below the point of observation. Studies of the life history and migrations of the salmon of the Pacific Coast States have been continued as in previous years.

Investigations of the fishes of the whitefish family have been continued and during the fiscal year were extended to Lake Superior. Some of these fishes are of great present commercial importance and others have potential value but are not now exploited because of their place of occurrence, the ignorance of the fishermen concerning their habits and habitats, or the inhibitions imposed by laws and regulations made for the protection of some other species.

These studies have included the systematic relationships of the several species, their distribution, life histories, and habits, rate of growth, ages at maturity, and maximum size, etc. Certain of these, particularly the age at maturity, appear to be subject to local variation. It is expected that a report embracing facts of value to fish culture and serving as a basis for rational conservation measures will be practically completed during the next year.

Owing to the great importance of the fisheries of Chesapeake Bay, the decline in numbers of certain important food fishes, the ease with which some of them can be intercepted and captured, and the fact that the waters of the bay are under the jurisdiction of two States that can not always reconcile their conflicting interests, it appeared important to undertake an investigation of the fishes in order to furnish information to those responsible for their conservation. The field work was begun near the end of the last fiscal year and has now been brought practically to a close. The study of collections and valuable notes and records accumulated has made some progress. The fishermen have evinced appreciation of the practical value of this work and have cooperated freely in supplying specimens and information and in giving access to fishing records.

Primarily as an incident to other duties, certain of the bureau's workers have been able to make material additions to knowledge of fresh-water fishes of economic value. In particular the information obtained concerning the natural history of the rock sturgeon is of importance in the formulation of measures to protect that valuable fish, which is yearly becoming less abundant.

Largely by volunteer cooperation with the faculty and graduate students of the University of Wisconsin, useful studies have been made of the food and feeding habits of certain fresh-water fishes.

INVESTIGATIONS RELATING TO FISH CULTURE.

The experiments in pond culture of the buffalofish that have been conducted at Fairport (Iowa) station for several years have demonstrated that while not entirely necessary it is definitely advantageous to cause a rise in the water level of the pond at the spawning time, thus simulating by the production of an "artificial flood" the conditions that prevail at the annual rise of the streams of the Mississippi Valley. In a pond used in the experiments the progeny of eight fish at the end of the season numbered 98,000 fingerlings from 2 to 5 inches long, a product equivalent to a yield of about 1 ton of fish to the acre. A paper on the pond culture of buffalofish, one of the most important food fishes of the Mississippi, has been prepared for the instruction of owners of ponds desiring to raise fish for home or local consumption.

The beneficent and maleficent relations of aquatic insects to pond culture was continued as a useful subject of investigation during the year. The life histories of nine species of beetles and bugs were worked out, and methods of control of the undesirable species have been indicated.

At the request of the Iowa State Game and Fish Commission an examination was made of Clear Lake, Iowa, which resulted in recommendations toward the development of a commercial fishery for "rough" fish, the propagation of game fishes, and the general management of the water area in the interest of increased fish production.

Suggestion having been made that the method of stripping salmon and trout now practiced at the bureau's stations was faulty, a scientific assistant was detailed to cooperate with the fish-culturists at Erwin (Tenn.) station in experiments to determine whether the method suggested, in which the fish is held in the natural position, belly down, and the pressure applied only back of the ventral fin, was superior to that now employed. It was determined that the established method, when carefully and skillfully applied, is better than that proposed, principally for the reason that less time is required in the operation and the fish subjected to less handling.

The position of fish-pathologist was filled in February, after a long vacancy, and the new incumbent has been active in investigating the causes of disease and mortality in fishes both in the bureau's hatcheries and in wild waters. Immediate and particular attention was devoted to the high mortality among rainbow-trout fingerlings shipped from White Sulphur Springs (W. Va.) station, and it was practically determined to be due to a protozoan parasite occurring in vast numbers in the intestine. This organism appears to have an unusual life history, and it is still under investigation in the hope that a weak link in its life chain may be found to furnish a point of application for remedial measures.

Various assistants and collaborators of the bureau have examined into the occurrence and causes of the death of fishes in lakes and streams, and progress has been made in the study of conditions affecting the prevalence of parasitism in fishes in natural waters and the possible relation of parasites to retardation of growth in their fish hosts. For a number of years there has been a number of deaths among diamond-back terrapin hatched at Beaufort (N. C.) station and held under the unnatural condition of nonhibernation and winter feeding. This has now been determined to be due to a characteristic bacterial organism, and further studies may develop methods of combating the disease.

STUDIES OF RIVER, LAKE, AND SEA.

In its investigations of mortality and diseases of fishes, oysters, crabs, etc., and of the causes of sudden or gradual changes in their abundance the bureau has often been baffled by the lack of accurate knowledge of normal physical, chemical, and biological conditions in the waters affected. With the purpose to remedy this deficiency an investigation of Chesapeake Bay was undertaken during the fiscal year 1921. The field work was practically completed in that year, but two supplementary cruises were made in 1922. During the year covered by this report attention has been devoted to the compilation and digestion of the physical and chemical data relating to the waters of the bay and to sorting the biological material preparatory to assigning it to the specialists for study and identification.

Research of the same character was begun during the year in Long Island Sound and contiguous waters, where the investigations of the bureau and of the States concerned into the difficult problems presented by the failure of the oyster set have been hampered by lack of information concerning the extent and dissemination of pollutions inimical to oyster culture and fishes and the character of the currents and the distribution of temperatures and salinity of the water.

In view of the recent and prospective development of hydroelectric projects much interest attaches to the effects of dams and artificially impounded waters on the fisheries of interior waters. When the great dam across the Mississippi River was constructed a number of years ago many persons expressed the opinion that, particularly in the absence of a fishway, the value of the fisheries of the upper river would be seriously impaired. For this reason the bureau has kept Lake Keokuk, the large body of water thus created, under periodical observation, and during the months of July, August, and September, 1921, it made an examination to determine the quantity of fish feed developed in this lake as compared with the natural river and Lake Pepin, a natural lake of about the same size, lying in the course of the Mississippi River in Minnesota and Wisconsin. It was found that the content of floating organisms (plankton) per unit of water volume was considerably greater in Lake Keokuk than in the adjacent part of the river but much less than in Lake Pepin. The yield of the fisheries in the part of the stream covered by Lake Keokuk has increased since the erection of the dam, probably as a result of the increased food supply.

At very small expense the bureau has been able to continue cooperation with the Wisconsin Geological and Natural History Survey in very important and fundamental investigations of the fish food resources of small lakes. The results indicate a surprisingly high production of plants and animals per unit of water surface and confirm the opinion long held of the potential importance of lakes and ponds as producers of food.

FRESH-WATER MUSSELS.

The propagation of fresh-water mussels, which provide the raw material for the valuable pearl-button industry of the Mississippi Valley, years ago attained large proportions and in the opinion of the industry has achieved results. The bureau has not been satisfied, however, to rest on present accomplishment but is constantly striving to improve the economy and effectiveness of the work and to extend it to species that have not satisfactorily responded to the methods now employed. For these reasons a material part of the activities of Fairport (Iowa) laboratory have been devoted to research and experiment on these river mollusks. If a satisfactory method could be developed for rearing the juvenile mussels to a stage at which they could be planted directly on suitable bottom a definite advance in mussel propagation in public waters would be achieved, and it would make possible a system of private mussel culture comparable with that extensively practiced with the oyster in coastal waters.

Some of the experiments in this field at Fairport have been highly successful, while the results of others conducted under seemingly favorable conditions have been insignificant. There are unknown or unrecognized conditions involved, and in addition to the direct experimentation the attachés of the station have undertaken the comprehensive study of all of the biological and physical factors that may have bearing on the subject. The work as a whole has given such encouragement of ultimate success as to make its continuance imperative.

In the method of mussel culture now practiced it is necessary to handle large numbers of live fish, and the minor injuries that they

receive permit infections by bacteria and "fungus," which often result in death. It has been discovered that this difficulty may be overcome by immersing the fish in a solution of copper sulphate after the encystment of the glochidia. The latter are not injured by the treatment.

The recommendations of the bureau for extending protection to mussels having been given effect by a number of the States, some of the closed areas have been placed under systematic observation to determine the results. The condition of the beds has been determined with respect to the abundance and ages of shells of different species for comparison with similar data to be collected five years hence.

An examination of the records of the catch of mussels on White River, Ark., over a period of years has confirmed the observations of mussel buyers on the stream that the artificial propagation of the yellow sand-shell on the river a number of years ago has resulted in a material increase in the production of that valuable shell.

OYSTER INVESTIGATIONS.

The grave difficulties with which the oyster industry has had to contend in recent years, particularly in Long Island Sound and on the south wash of Long Island, have continued to receive the bureau's attention.

In Long Island Sound the set of young oysters has never been regular within historic times, but until recently it occurred with sufficient frequency to permit the upbuilding of the most extensive oyster-cultural operations in the country. This region is on the minimal temperature verge of the oyster's habitat, and the investigations made by the bureau have now shown that a water temperature suitable for spawning and the development of the oyster larvæ is attained for but a short time each year. In the summer of 1921 this temperature was reached exceptionally early, but this condition, which ordinarily would have been favorable, was interfered with by subsequent cold, rainy weather, during which the larvæ disappeared.

The inshore, shoaler, warmer waters, which formerly supported the natural beds furnishing the spat that seeded the planted beds in the colder deep waters of the sound, have been largely depopulated by pollution with trade wastes. The solution of the problem appears to lie in planting and maintaining spawning beds in shore waters not yet seriously contaminated and in reducing the pollution now existing in other areas. The work in Great South Bay revealed an early occurrence of spawning and a great abundance of oyster larvæ widely distributed, and, later, a correlated abundance and distribution of young oysters on the planted shores. Still later practically all of this set died, and the investigator is of the opinion, although it was not possible to demonstrate it as a fact, that this mortality was due either to the generation of toxic gases or the exhaustion of oxygen by the organic matter in the bottom mud. It was observed that the oysters that had set on materials experimentally raised above the bottom survived, and the investigator has suggested to the planters that a similar method be tried commercially during the season of 1922.

During the year a plague of mussels interfered seriously with the oyster industry of Chesapeake Bay. An investigation in December and January indicated that the distribution of the mussels was limited within a narrow range of salinity of the water and was probably due to the paucity of rainfall during the preceding summer. This is one of the oysterman's troubles that is beyond control but that, while costly during its prevalence, will correct itself.

POLLUTION OF WATERS.

Pollution of interior streams and waterways by industrial wastes and municipal sewage has been the subject of complaint and protest for many years. Industry, itself, frequently has been a victim of its own acts through inability to use the polluted water with safety in boilers or for the many other industrial purposes that require pure water. The public health has been menaced, public works have been damaged, agriculture has suffered, and in some parts of the country the streams have been swept bare of living things, including fishes and other animals of economic importance. Recently the vast development of petroleum production and transportation, the use of its derivatives for manifold purposes ashore, and particularly as fuel on ships, has introduced a new element of serious pollution in the great harbors and in places on the open coast.

The pollutions are almost as varied as industry and in many cases are not only complex in themselves but are further complicated by their reactions on one another and on the natural constituents of the waters themselves. The waters can not be restored to their pristine purity, nor to any state approaching it, by mere legislative fiat, and the sooner that fact is appreciated and constructive measures are taken the better for the public welfare.

The pecuniary losses now suffered as the result of water pollutions are enormous, and the preventable damage to the life and beauty of our streams, lakes, and seacoast is beyond estimate in terms of mere money. If existing abuses are to be corrected and new ones prevented without inflicting widespread economic injury, something more constructive than drastic laws must come into being. There must be corrective legislation, but it should be based on something more substantial than a perfectly justifiable desire for improvement. Complete utilization of raw materials is an ideal not attainable. Industry must be accompanied by "waste," and the wastes must be disposed of in some manner. The problem is to devise ways of disposing of them so as to minimize their harmfulness while still permitting industrial development. This is the problem of the biologist, the chemist, and the engineer working in cooperation.

The effects of these pollutions on the fisheries are the only phases of the subject that officially concern the bureau, and it has continued to endeavor, so far as its means would permit, to contribute to the solution of the problems involved; but it is futile to expect that much can be done unless money and, particularly, trained and capable men are provided for the purpose of determining facts and their practical and scientific implications.

BIOLOGICAL LABORATORIES.

The laboratory at Woods Hole was not operated during the summer of 1921 because of the limitation of funds, but its facilities were

extended, at no expense to the bureau, to a number of investigators connected with the Marine Biological Laboratory. In the summer of 1922 the laboratory was reopened with a very small staff of the bureau's workers and a considerable number of volunteers investigating marine biological problems of their own selection.

The station at Beaufort continued without a scientific director on account of the inadequacy of the salary to attract a man with sufficient training to discharge the duties of the position. Experiments in terrapin culture were continued, and the facilities of the station were utilized by the Navy Department for investigations relating to the prevention of fouling of ships' bottoms. Several independent investigators were also accommodated.

With the exception of two months the laboratory at Key West has been without a technical staff on account of the low salaries.

The principal work of the Fairport (Iowa) laboratory has been briefly described elsewhere in this report.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

REVIEW.

During the fiscal year 1922 the fish-cultural work of the bureau was conducted along established lines on the usual extensive scale and with satisfactory results despite many difficulties. On the Pacific coast low water, followed later by freshets, affected the collection of salmon eggs. Through the Great Lakes region warm weather in the early part of the season retarded the run of whitefish and lake trout and lowered the quality of their eggs, but conditions improved later. Unseasonable weather occurred during the period when the pondfishes were spawning and resulted in chilling the eggs of the basses, crappie, sunfish, and other spring-spawning species.

A comparison of egg collections and of the output of the hatcheries with the previous year shows a considerable divergence in the numbers of the various species handled. The present year exhibits an increase in the output of such species as the buffalofish, glut herring, shad, whitefish, Pacific coast salmon, trouts, yellow perch, cod, striped bass, and winter flounder, while decreases are evident in the output of carp, smelt, pike perch, haddock, and pollock. These annual variations may be accounted for primarily by climatic conditions, which favorably or otherwise affect the spawning of any species. Another factor that contributed largely to the decreases in output was the reduction of funds for fish-cultural operations. The force for the collection of eggs must be assembled and placed in the field in advance of the expected run of fish, that they may be in readiness to secure the eggs as soon as they are available. In many very promising fields it was not possible to conduct operations until the close of the season nor to hold the field force for delayed runs of fish on account of limited funds.

The most important operations of the division of fish culture are those addressed to the maintenance of certain of the great commercial fisheries, which because of their magnitude must be considered factors of importance in the maintenance of the fish supply of the country. A reduction in the general fund set aside for the propagation and distribution of food fishes must necessarily affect this class of work.

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Further points of interest to be noted in comparing the present season's output with that of 1921 is an increase of approximately 33 per cent in the production of fingerling fish, a decrease of 6 per cent in operating costs, and ~~a decrease of but 1~~ per cent in the aggregate output. The output for 1922 was ~~4,925,081,320~~, as compared with 4,962,489,405 for 1921, while the cost per million fish produced for distribution for the present year was $~~125.57~~, as against $128.06 for 1921.

During the fiscal year 1922 fish-cultural work was conducted in 33 States and in the Territory of Alaska through the operation of 38 main stations and 35 auxiliaries. At these stations over 40 species of valuable food fishes were propagated. The output may be classified on the following geographic basis, which agrees with the general character of operations at the hatcheries: Anadromous species of the Atlantic coast, anadromous species of the Pacific coast, marine species of the Atlantic coast, fishes of the Great Lakes, and fishes of the interior waters.

Summary, by species, of the output of fish and fish eggs during the fiscal year ended June 30, 1922.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish			52,137,880	52,137,880
Buffalofish	86,906,000	51,000,000	3,341,480	141,247,480
Carp		82,050,000	22,006,805	104,056,805
Shad		63,461,200		63,461,200
Glut herring		82,600,000		82,600,000
Whitefish	156,242,000	306,350,000		462,592,000
Cisco	220,690,000	47,400,000		268,090,000
Chinook salmon	1,400,000	1,311,550	57,769,870	60,481,420
Chum salmon		1,540,000	14,027,610	15,567,610
Humpback salmon		369,860	1,119,400	1,489,260
Silver salmon		600,000	11,074,940	11,674,940
Steelhead salmon	450,000	20,000	2,028,220	2,498,220
Sockeye salmon	150,000	32,600,000	59,522,365	92,272,365
Atlantic salmon		1,334,000	180	1,334,180
Landlocked salmon	115,000	187,230	95,780	398,010
Rainbow trout	2,377,840	410,700	4,439,685	7,228,225
Blackspotted trout	1,097,500	493,400	931,000	2,521,900
Loch Leven trout			56,000	56,000
Lake trout	2,796,000	29,359,365	213,090	32,368,455
Brook trout	255,000	3,019,050	6,717,805	9,991,855
Grayling		250,000		250,000
Smelt		300,000		300,000
Pike and pickerel			679,795	679,795
Crappie			36,468,545	36,468,545
Largemouth black bass		281,700	1,652,710	1,934,410
Smallmouth black bass		568,250	76,990	645,240
Rock bass		800	52,095	52,895
Warmouth bass			2,515	2,515
Sunfish			52,697,985	52,697,985
Pike perch	79,650,000	55,897,500	34,390	135,581,890
Yellow perch	34,400,000	207,527,000	1,604,350	243,531,350
White bass			36,510	36,510
Striped bass		25,530,000		25,530,000
Fresh-water drum			242,025	242,025
Cod	~~84,164,000~~	232,131,000		~~316,295,000~~
Haddock		290,820,000		~~290,820,000~~
Pollock		327,380,000		327,380,000
Winter flounder	193,178,000	1,867,378,000		2,060,556,000
Pole flounder	5,090,000			5,090,000
Mackerel		1,980,000		1,980,000
Scup		2,505,000		2,505,000
Sea bass		32,000		32,000
Miscellaneous river fishes			10,402,355	10,402,355
Total	~~868,961,340~~	3,716,687,605	339,432,375	~~4,925,081,320~~

75,960,000

208,224,000

440,3…

1,068,981,340

5,125,1?1,32…

DISTRIBUTION OF OUTPUT OF HATCHERIES.

The output of the hatcheries is given a wide distribution, fish or eggs being delivered to interested persons and State commissions in practically all parts of the country, including Alaska. To accomplish this, five specially equipped railroad cars, having living quarters for a crew of five men and compartments in which live fish may be carried several days without loss, were in active service through the greater part of the year. These cars traveled 77,128 miles, and detached messengers in charge of consignments of fish traveled 306,215 miles, in the efforts of the bureau to supply over 10,000 applications for fish.

The cars were employed principally in distributing the fishes of interior waters, which were supplied on requests of individuals, fisheries associations, and State fisheries officials, and to waters of national parks, Forest Reserve, and Reclamation Service. The commercial species of the Atlantic and Pacific coasts and of the Great Lakes are distributed for the most part by boats operated by station crews. These fish are liberated on the natural spawning grounds, or, in some instances, in barren waters where conditions favor their development. Nonindigenous fishes are introduced with great caution and only after a study of environment and careful consideration as to the future effect that the introduced species may have on the indigenous fishes. This is especially true with reference to the introduction of the spiny-rayed fishes into trout or salmon waters. Trout eggs have been successfully planted in some of the more remote waters of mountainous regions by depositing them 10 or 12 days previous to the hatching period; approximately 10,000 to 15,000 eggs are allowed to a mile of stream.

RELATIONS WITH STATES IN FISH CULTURE.

Closer cooperation has been brought about between the bureau and many States engaged in fish culture, since it has been pointed out to them that there is more or less duplication of effort in stocking waters. In many instances the States and the bureau combined money and forces, resulting in a saving of funds and more efficient work. States having inadequate or no hatching facilities have been permitted to utilize the bureau's hatcheries for the purpose of incubating their eggs, when the same could be done without interference with the bureau's operations. Increased travel in the United States, especially by automobile, has caused a serious depletion of fish life in many sections, and the States realize that their institutions are not capable of coping with the situation alone. By a combination of effort eggs and fish are moved from one section of the country where they may be surplus to another where they may be used in stocking depleted waters. Fish are removed from overcrowded waters where they serve as forage for larger fishes and are placed in more suitable environments where they will eventually be of benefit to the public. The State authorities lend their assistance and cooperation in making this interchange possible and profitable.

During the year the bureau found it necessary to call the attention of State officials to the great and growing need for more adequate laws for the protection of food and game fishes. This need

applies to the Southern States more than to any other section, as waters that were once teeming with various species of fish are now becoming depleted, owing largely to the increase of tourist fishermen. The waters of the Southern States are naturally very productive, more so, possibly, than those of any other part of the United States, and owing to the abundance of natural food developed in them bass and other species grow to large size. In some sections the fish receive no protection whatever during the spawning season, when fishing should be absolutely prohibited. Many States have shown a deep interest in this matter, and in response to the bureau's recommendations have expressed the intention of bringing about the needed reforms in fishery legislation. The most notable example is Texas, which has recently passed special legislation covering the protection of bass and most of its important food fishes.

Mutually profitable cooperative relations have continued between the bureau and the Canadian fisheries authorities. Exchanges of Atlantic salmon eggs for eggs of the rainbow, brook, and blackspotted trouts have been made, and the collections of whitefish and cisco eggs in the Great Lakes regions have been largely increased by the fact that the Canadian authorities allowed the bureau's men access to waters in Canadian territory. The result of this cooperation has been a greater output of these species by both Governments.

During the fiscal year 1922 the fisheries authorities of 26 States were supplied with fish or fish eggs, as shown in the following table:

Allotments of fish and fish eggs to State fish commissions, fiscal year 1922.

State and species.	Eggs.	Fingerlings.
Idaho: Whitefish	1,000,000	
Illinois:		
Black bass		227
Carp		100
Catfish		15,165
Crappie		4,800
Drum		10
Pike		50
Rock bass		40
Sunfish		30,800
Yellow perch		25
Indiana: Pike perch	13,800,000	
Iowa:		
Brook trout		41,500
Lake trout	50,000	
Pike perch	5,100,000	
Rainbow trout	206,000	1,500
Kansas: Yellow perch	5,000,000	
Maine: Lake trout	50,000	
Maryland:		
Cisco	1,000,000	
Chinook salmon		5,000
Rainbow trout	135,000	
Massachusetts:		
Buffalofish		250
Catfish		4,000
Michigan:		
Cisco	32,500,000	
Lake trout		600,000
Rainbow trout	50,000	
Pike perch	56,500,000	
Albino brook trout		10,000
Minnesota:		
Black bass		6,395
Crappie		3,150
Lake trout	1,200,000	
Steelhead salmon	50,000	
Sunfish		39,050
Yellow perch		120
Missouri:		
Rainbow trout	113,000	36,280
Yellow perch	4,000,000	
Montana:		
Blackspotted trout	587,500	
Chinook salmon	100,000	
Lake trout	100,000	
Rainbow trout	215,000	
Steelhead salmon	72,000	
Whitefish	5,000,000	
New Hampshire: Lake trout		14,000
New Jersey: Lake trout	25,000	
New Mexico:		
Brook trout		36,000
Rainbow trout	75,000	
New York:		
Cisco	16,050,000	
Lake trout	1,000,000	
Steelhead salmon	50,000	
Whitefish	15,000,000	
North Dakota:		
Black bass		930
Catfish		5,600
Crappie		280
Sunfish		4,380
Yellow perch		700
Oklahoma: Rainbow trout		113,500
Oregon:		
Chinook salmon	1,300,000	
Grayling		25,000
Pennsylvania:		
Catfish		200
Cisco	114,300,000	
Lake trout	50,000	
Pike perch	4,200,000	
Steelhead salmon	50,000	
Whitefish	32,340,000	

Allotments of fish and fish eggs to State fish commissions, etc.—Continued.

State and species.	Eggs.	Fingerlings.
Tennessee: Rainbow trout	50,000	16,000
Utah:		
Brook trout	250,000	
Lake trout	100,000	
Vermont:		
Lake trout	25,000	91,865
Rainbow trout		3,000
West Virginia: Rainbow trout		116,000
Wisconsin:		
Black bass		6,790
Catfish		1,920
Wisconsin—Contd.		
Crappie		660
Sunfish		8,400
Yellow perch		2,975
Whitefish	21,000,000	
Wyoming:		
Blackspotted trout	250,000	
Brook trout		24,000
Lake trout	100,000	
Rainbow trout	446,240	
Total	333,519,740	1,270,662

Shipments of fish eggs to insular possessions and foreign countries, fiscal year 1922.

Country and species.	Number of eggs shipped.
Canada:	
Blackspotted trout	200,000
Landlocked salmon	100,000
Rainbow trout	450,000
Whitefish	61,192,000
Czechoslovakia: Rainbow trout	100,000
Hawaii: Rainbow trout	51,000
Switzerland:	
Lake trout	50,000
Rainbow trout	50,000
Total	62,193,000

COOPERATION WITH FISH-PROTECTIVE ASSOCIATIONS.

Realizing the necessity of greater protection for interior waters, the bureau has corresponded on the subject with fishing clubs and others who are interested in fishery matters. Many clubs have shown a willingness to protect the fish until they attain maturity and to curtail the number that may be taken. In some instances associations are holding fish furnished by the bureau in specially constructed ponds, where they will be fed and liberated later in the season. This cooperation has had the effect of reducing expenses and increasing the chance of survival of the fish furnished. The National Forest Service has taken the lead in this respect, having already established many ponds in the territory under its control. Many of the forest rangers have been instructed in the handling of fish and their proper distribution, and a record has been kept of all suitable streams and the number of fish liberated therein. The bureau has been pleased to cooperate with such organizations.

PROPAGATION OF MIGRATORY FISHES OF ATLANTIC RIVERS.

The results of shad propagation on the Potomac River were good. Weather conditions throughout the season were generally favorable; there was a large catch of fish, and the take of eggs was over three times that of last year. The total output of the Edenton (N. C.) station was also materially increased. In this region the extensive operation of pound nets has had the effect of considerably curtailing the output of shad fry as compared with past years, most of the shad

under present conditions being taken in a green state, between salt water and the spawning grounds. A few fishermen were permitted to operate gill nets on the spawning grounds under licenses issued by the State, and the eggs taken from the fish caught are turned over to the hatchery. The most notable increase in the work at the Edenton (N. C.) station during the year was in the collection of glut-herring eggs. This species has commercial importance in Albemarle Sound, and it appears worthy of increased attention.

In the Roanoke River, in the vicinity of Weldon, N. C., striped bass appeared in large numbers, and over 48,000,000 eggs were obtained, fully twice the number in any preceding year. The greater part of this increase was due to the more effective work of the fishermen in supplying ripe eggs to the bureau's hatchery.

In advance of the shad-hatching season the Bryans Point (Md.) station was engaged in yellow-perch propagation. Eggs of this species are secured by collecting the adult fish and holding them in specially constructed live cars anchored in creeks near the hatchery until their eggs have been deposited, when they are liberated. The eggs are transferred to hatching jars, and the resulting fry are liberated in the streams from which the fish were derived. During the season a total of 21,620 adult yellow perch were collected, and from the females, which constituted about three-fourths of the lot, 199,660,000 eggs were taken, practically all of them being of first quality.

The propagation of Atlantic salmon at the Craig Brook (Me.) station was conducted as heretofore. At the beginning of the year there were on hand in the station inclosure awaiting the ripening of their eggs 199 adult wild salmon that had been purchased during the preceding two months from commercial fishermen, but the number was reduced at spawning time in October to 190, from which 572,000 eggs were taken. In addition 1,000,000 eyed eggs were received from the Candian Government in March, in exchange for trout eggs, and from the combined stock 1,334,000 fry were liberated in the Penobscot River and tributaries in the month of May. At the close of the fiscal year 47 adult salmon were being held in the station pound. The number obtained was considerably smaller than usual, the decrease being due mainly to the low market price for Atlantic salmon, which did not justify the fishermen in expending much money in equipment.

During the fall of 1921, 445,000 eggs were secured from wild humpback salmon taken from Dennys River, at Dennysville, Me. These were incubated at the Craig Brook (Me.) station, producing approximately 370,000 fry for return to the Dennys River and tributaries. This run of fish resulted from the transfer of humpback salmon eggs from the Afognak (Alaska) station in November, 1917, being the second generation to ascend the river for reproduction. It therefore appears that the humpback salmon has become well established in the waters of the Maine coast.

PROPAGATION OF COMMERCIAL FISHES OF GREAT LAKES.

The bureau's operations in this region are confined to the propagation of such species as whitefish, cisco, lake trout, and pike perch. Operations with the first two species showed a satisfactory increase

in output as compared with previous years, this being made possible largely by favorable weather conditions in the latter part of the season, which permitted the commercial fishermen to operate their boats and handle their nets at the time the fish were on the spawning grounds. However, in the Saginaw Bay field, in Michigan, the collection of pike-perch eggs was brought to a sudden close a few days after the opening of the season by a severe storm that destroyed many of the nets belonging to the commercial fishermen. The need of a hatchery at some point on Saginaw Bay to take care of the immense numbers of pike-perch and yellow-perch eggs now being wasted in the fisheries in that field, is as great as formerly. It it estimated that approximately 1,000,000,000 eggs of each of these species are lost each year owing to the lack of proper hatching facilities for handling them. The eggs can not be successfully hatched at any of the interior stations because the water conditions there are not suitable, and the cost of transferring the eggs to distant hatcheries and returning the fry to the parent waters would be prohibitive, even if water conditions were favorable.

In compliance with demand, carp propagation in the western end of Lake Erie was prosecuted, as heretofore, from the Put in Bay (Ohio) station and about 82,000,000 fry were liberated in Portage River and adjacent waters. Through the courtesy of Port Clinton (Ohio) fishermen, the bureau installed and operated a temporary hatchery in one of the fish houses.

No attempt was made to collect whitefish eggs in the extreme western end of Lake Erie, as there were not sufficient fish on the grounds to warrant the fishermen in operating their nets. The falling off in the run of whitefish in this section of the lake in recent years is attributed to trade wastes from the Raisin, Maumee, and Detroit Rivers. The fishermen are convinced that the fish are seeking new spawning grounds, and most of the eggs obtained during the season were derived from fish taken in the vicinity of Middle Bass, North Bass, and Catawba Islands, and Port Clinton, Ohio. There was a good run of fish in these fields, and the Put in Bay hatchery was filled to capacity with eggs, the total collection amounting to 385,820,000.

PROPAGATION OF PACIFIC SALMONS.

There was an excellent run of sockeye salmon in the vicinity of the Afognak (Alaska) station. No trouble was experienced in securing all the eggs the hatchery could care for, and it was estimated that not over one-fourth of the available fish were used in the spawning operations. The take of eggs of this species for the season amounted to 53,835,000. On account of the warm weather during August and September the eggs advanced to the hatching stage fully three weeks earlier than under normal conditions, but no difficulty was encountered in holding the fry on the trays until the proper time for their distribution. A new method of transporting the fry, suggested by Alfred Nelson, was tested with good results. The fry were moved on trays stacked on a Yukon sled, with a tarpaulin covering, and it was found they could be transported in this way without bad effects when out of the water for as long as half an hour. A number of eggs that had been placed as an experiment in

gravel in an old hatching trough held in the creek were found to be a total loss, the eggs dying apparently on reaching the eyed stage.

The collection of sockeye-salmon eggs at the Yes Bay (Alaska) station extended from August 29 to September 27, 51,000,000 being taken. Protracted rains after the middle of September caused very high-water stages, which interfered to a considerable extent with seining operations. The first eggs taken showed the eye spots by September 27, and by November 1 all of them were eyed. The fry were held on trays in the hatching troughs until the sac was absorbed and they had commenced to come to the surface in search of food. A branch of the creek in front of the hatchery approximately 2,000 feet long was closed with a rack and stocked with fry, and in this protected area where the fry were fed, the edges of the grass and numerous little indentations along the bank were literally swarming with young fish. It is believed that this method of holding the fish more nearly approximates natural conditions and that the resulting fingerlings may be safely liberated in the body of the lake in the month of June, at which time but few of their natural enemies are present. The fry held in the hatchery were fed from June 1 to 29, when the food supply of salted salmon was exhausted and it became necessary to plant the entire stock. Two million fry were held in McDonald Slough, an arm of the lake located about 4 miles from salt water. They were put into the lake on May 11, and by July 25 those observed around the shores were 2 inches long. On September 10 the screen was removed and the fish were permitted to migrate into the main body of the lake. An experiment was tried of planting eggs within four or five days of hatching in the sand and gravel around the shores of several neighboring lakes. It is believed that such bodies of water as appear to have sufficient natural food may be stocked by this method and that the young will escape to the sea during high-water periods without injury. The usual run of humpback salmon entered the lake early in July, and approximately 246,000 eggs of that species were taken.

Operations were conducted at Baker Lake and at six of its auxiliaries in Washington. Five of these stations were open during the entire year, and all species of Pacific coast salmon and the steelhead were handled, the total egg collections of the group amounting to 47,693,000. Although there was a slight decrease in egg collections at some of the stations, the work as a whole exceeded that of the past year. At Baker Lake the work of constructing buildings to replace those destroyed by fire several years ago was completed, and a new trap was installed at the outlet of the lake. This trap is located some distance below its predecessor and apparently functions better. The new hatchery has a capacity for 30,000,000 eggs and 25,000,000 fry, when carried in the stacked tray system. The usual fish-cultural operations and repairs were conducted at all of the substations in Washington. Humpback salmon began ascending Duckabush River in the vicinity of the bureau's station on September 2, and the run lasted an entire month. It is believed that fully 75 per cent of this run escaped the traps and spawned naturally. Eggs to the number of 874,000 were collected, and the resulting fish were returned to the river in the advanced fry stage.

At Quinault Lake (Wash.) station, two concrete rearing ponds of the long narrow type with sloping sides were constructed. They

are 75 feet long, 6 feet wide, with an average depth of 30 inches, and have an estimated capacity of 50,000 sockeye fingerlings. Shortly after September 15, traps were placed in the rack at Big Creek, and the equipment was made ready for the spawning season, which opened October 1. The sockeye salmon counted through the trap at the end of June, 1922, numbered 199,489, in addition to 429 steelheads and 251 blackspotted trout. It is estimated that the run was equal to the big run of 1915. Many of the Indians secured excellent catches of salmon, some taking as many as 300 fish per day with dip nets, and a profit of from $200 to $300 per day for the gill-netters was not unusual. A price of 50 cents per fish, regardless of size, was paid by the packers throughout the season. Of the salmon counted at the weir 8.8 per cent had received gill-net markings at the mouth of the river.

Fish-cultural operations were conducted as usual in the California field, and at Baird and its two auxiliaries an average number of fry was held and fed to the fingerling stage. The total number of chinook-salmon eggs collected amounted to 6,353,000. All of these stations are in need of extensive rearing ponds and a more adequate water supply.

The usual egg collections were made at the stations in Oregon, although a rise in the Clackamas River ended the season suddenly at Clackamas station on October 28, when a portion of the rack was carried away, allowing large numbers of chinook and silver salmon to pass upstream. Both runs of chinook salmon were equal to expectations throughout the field except on the Rogue River and in Idaho, the take of eggs at these points being materially lessened by high water during the late spring when the snow was melting. At Clackamas and its auxiliaries 63,685,000 eggs were collected, of which 57,885,000 were chinook salmon. Salmon fry to the number of 51,446,000 were retained at the various points to be fed, but it was found later that this heavy stock was overtaxing the capacity of the hatcheries, and the surplus had to be released. It is very essential that increased holding space be provided in advance of another season's operations so that all salmon produced may be held and fed for liberation at a more advantageous period. The fish held appeared to thrive and showed no ill effects from a diet of middlings mixed with meat. It has been found that by feeding the fish slowly twice a day the results are better than if fed from four to six times daily. In liberating the fish from the sloughs and other inclosures experience has shown that it is preferable to release them in small lots.

PRODUCTION OF MARINE SPECIES.

Collections of eggs at the marine stations exceeded those of 1921 by approximately 300,000,000, but the output was materially less than in the preceding year, owing to the adverse conditions under which the eggs were obtained and their resultant inferior quality. On account of the shortage in funds spawn takers could not be placed on the vessels of the offshore fishermen to fertilize and plant the ripe spawn taken. The Boothbay Harbor (Me.) station confined its efforts to the propagation of the winter flounder, of which the output amounted to 922,-

777,000. Operations at the Woods Hole (Mass.) station were somewhat restricted on account of the few vessels operating on the fishing grounds as a result of the low market price for fish. Another factor that largely affects the success of the cod work at this point is that comparatively few of the vessels operating on the more important fishing grounds are constructed with wells for the transportation of live fish, and the supply of brood fish, therefore, is limited. During the season 4,023 brood cod were received, and from them 280,466,000 eggs were obtained. The propagation of winter flounders was unfavorably affected by weather conditions, the severe cold at times making it necessary to cut through several feet of ice in setting and attending the nets. At Waquoit but 71 brood females, yielding 819,927,000 eggs, were obtained. Work at Wickford, R. I., which is conducted later in the season, was almost a failure on account of unseasonably high-water temperatures. The steamer *Halcyon* was put into the Newport field to collect eggs from fish caught in deep waters, but owing to the great depth and consequent low-water temperatures the fish did not spawn freely until it was too late in the season to make successful shipments of eggs to the hatchery. From a consignment of 25,000 steelhead eggs transferred to the Woods Hole station from Birdsview, Wash., 20,000 fry were hatched and liberated in suitable waters on Cape Cod, most of them being placed in Johns Pond, at Mashpee, Mass.

Pollock work was taken up by the Gloucester (Mass.) station in November. Throughout the season there appeared to be an abundance of pollock on the inshore fishing grounds, but they were continually moving, causing great fluctuation in the daily catch and necessitating frequent shifts of nets. Owing to this difficulty the total egg collections for the season amounted to but 507,270,000, nearly 100,000,000 less than in 1921. The experiments with the pole flounder undertaken in the spring of 1921 were continued into July, and considerable information regarding the nature of the fish was secured. It appears that most of the fish spawn in August and September. The eggs are about one-twentieth of an inch in diameter, numbering approximately 470,000 to the liquid quart; they are buoyant, transparent, nonadhesive, and can not be successfully transported from the spawning grounds to the hatchery, and it would appear necessary, if the propagation of the species is to be continued, to secure eggs from the ripe fish caught by the commercial fishermen, fertilize them, and plant them on the spawning grounds. The collection of cod eggs for the Gloucester station extended practically through the entire winter and spring, though most of them were taken in March and April. During November and December numerous reports were received concerning the spawning of large numbers of cod off the coast of Plymouth, Mass., but on account of the bad weather it was not possible to make large collections there. In January in the Ipswich Bay field, the fishing boats were making large catches, when a heavy storm came up, scattering the fish and preventing fishing operations until late in March. With the approach of spring most of the gill-net fleet withdrew from this field, and from that time on the hatchery was dependent on the fleet of small boats operating there and in Massachusetts Bay. Heavy

spring rains sometimes cause the coastal waters to become so fresh that it is impossible to handle eggs of the marine species at the Gloucester hatchery, and under such conditions the spawn takers are instructed to carefully fertilize the eggs and plant them on the spawning grounds. The total cod-egg collections for the season amounted to 306,960,000, and owing to the water conditions 124,-060,000 of this number were fertilized and planted immediately. The haddock eggs secured were for the most part obtained from fish caught on the inshore grounds, especially during March and April, when 90 per cent of the collection was made. Collections earlier in the season were curtailed by heavy storms.

CULTIVATION OF FISHES OF INTERIOR WATERS.

The output of brook, blackspotted, rainbow, and Loch Leven trouts for the fiscal year amounted in round numbers to 20,000,000, a decrease of approximately 4,000,000 as compared with the previous year. Brook-trout operations at the Leadville (Colo.) station were very successful, and the large stock of eggs obtained produced a good percentage of vigorous fry, which were planted in the waters of Colorado, Wyoming, and Montana. Five hundred thousand eggs of this species were diverted to the Glacier Park hatchery for incubation and stocking the waters of that reservation. In cooperation with the State authorities, the superintendent of the Springville (Utah) station made a successful brook-trout egg collection, and after retaining a sufficient number of eggs to meet local requirements, 1,959,000 were shipped to other stations of the bureau and State hatcheries.

In an effort to establish a source of supply for steelhead eggs in eastern waters, a consignment of eggs of that species was shipped from Birdsview (Wash.) to Manchester (Iowa) station, the resulting fry to be reared for a brood stock.

The Meadow Creek station, in Madison Valley, Mont., was operated for rainbow-trout propagation as a subsidiary of the Bozeman (Mont.) station. A 6-inch wood pipe line was installed for the purpose of securing water from a spring and avoiding the use of creek water for incubation. The egg collection was somewhat smaller than that of the average season, due principally to adverse weather conditions during the spawning period. Through cooperation with the State of Montana, this station was kept open beyond the usual closing time, in order that the fry might be cared for until they had reached a suitable age for distribution in local waters. This avoided the heavy expense of shipping the eggs and returning the resulting fish from the main hatchery at Bozeman, and at the same time the loss was smaller and the fish better than would have otherwise been possible. By exchange, the bureau received a large number of blackspotted trout eggs from the Montana fisheries authorities. These eggs were considerably earlier than those produced in the Yellowstone park field and made possible a much more advanced distribution than usual from the Bozeman (Mont.) station.

Operations in Yellowstone Park were conducted by the superintendent of the Leadville (Colo.) station, who, with a force assembled at Gardiner, entered the park on May 25. The station was opened and racks installed in all suitable streams on the west side of the

lake. On account of the large amount of snow in the mountains to the east of the lake, the indications were that no fish would be found in the streams of that section until early July. Collections during June, 1922, were about equal to those during the entire season of 1921, and for the entire season of 1922 will probably be larger than the average. This increase is attributed to the heavier stocking of lakes and tributary streams in recent years, made possible by cooperation with the National Park Service. The superintendent of Yellowstone Park has rendered valuable assistance by furnishing pack trains for transporting the fish to the more inaccessible waters. Credit is also due the State of Wyoming for incubating eggs in the State hatchery at Cody and planting most of the resulting fry along the eastern boundary of the park. The Forest Service assisted in distributing fish in the waters along its southern and western boundaries.

The Saratoga (Wyo.) station constructed a field hatchery at Sage Creek, and succeeded in collecting 1,336,000 rainbow-trout eggs, most of which were utilized in stocking Wyoming waters, in cooperation with the State hatcheries. Glacier National Park hatchery was well stocked with eggs shipped from Bozeman (Mont.), Leadville (Colo.), and the Yellowstone Park (Mont.) stations, and a much larger number of fish were planted in the park than last year. In cooperation with the park authorities the waters have been catalogued, and an effort will be made to plant therein the most suitable species of fish, pursuing the work systematically from year to year. Assisted by Glacier Park and Montana fishery officials, the superintendent of the Bozeman (Mont.) station planted a consignment of brook-trout fingerlings in the headwaters of the Upper Kootenai River and Cameron Lake.

Spearfish (S. Dak.) station continued to make improvements to its pond system for the better handling of brook trout. This has been made possible through an arrangement with the city authorities for the use of the surplus water from the city reservoir. In the propagation of domesticated rainbow trout the results at this station continue to show improvement in both quality and numbers.

The most successful rainbow-trout work in the eastern section of the country was accomplished at the stations located at Neosho, Mo., White Sulphur Springs, W. Va., Erwin, Tenn., and Wytheville, Va. In recent years the output of rainbow trout from the Manchester (Iowa) station has been inferior, owing to the poor quality of its brood stock, but new blood has been introduced, and it is believed that this station will soon be producing eggs of its former high standard. Neosho (Mo.) station made arrangements with a company at Roaring River, Mo., for the collection of eggs from semiwild rainbow trout, and approximately 600,000 were secured from that source. At the Wytheville (Va.) station a filter and settling tank was installed for the purpose of eliminating roily water, heavy rains in that region causing the spring to become very turbid at times. This apparatus will remove approximately 90 per cent of the sediment from the water, making it practically clear at all times. Formerly it was almost impossible to rear young brook trout at this station, large numbers perishing every year during the roily-water period, but under the improved conditions it is believed no trouble will be experienced.

Anatomical studies of the rainbow trout by the division of scientific inquiry were continued throughout the year at the Erwin (Tenn.) station, and a number of facts pertaining to the reproductive organs of the female fish that were heretofore not understood have been brought out.

Climatic conditions during the spring of 1922 were not favorable to a large output of the pond fishes, except at San Marcos, Tex., and Louisville, Ky. At all the other stations of this class there was a marked decrease in the output, due to sudden changes in water temperature, which caused the bass to desert their nests.

Owing to lack of funds the bureau did not cooperate with the State of Minnesota in the collection of pike-perch eggs in the Rainy Lake region. Buffalofish propagation was conducted as usual in the State of Louisiana. Previous to the opening of the spawning season the hatchery on the Atchafalaya River was removed to Pelba, about 1 mile distant, because of the erosion of the river bank at the old site. Pelba is a more favorable location for the collection of buffalofish eggs, being nearer the center of the spawning grounds. Approximately 142,000,000 eggs were obtained, an increase of about 35 per cent over collections of the preceding year. The spawning season was delayed somewhat beyond the usual time by the backward spring, the first eggs being taken March 9, and on April 4 collections were discontinued on account of high water. Taking advantage of an opportunity, the bureau collected approximately 57,000,000 buffalofish eggs in connection with fishing operations on the upper Mississippi River at Bellevue, Iowa, and Lynxville, Wis. This is considered conservation work oft he highest importance, since the eggs would be sent to the market and lost were it not for the intervention of the bureau.

RESCUE OPERATIONS IN MISSISSIPPI RIVER VALLEY.

The salvage of food fishes from the temporarily overflowed lands along the Mississippi River has continued to be a prominent duty of the fish-cultural service. All of the important old fields were occupied, but no new territory was covered for lack of funds. The work at Meredosia, Ill., was discontinued, because the former fields are now utilized for agriculture and by clubs interested in creating duck-shooting preserves. The owners of preserves refused to permit the bureau to operate seines in the pools on the ground that it would disturb the ducks and destroy their natural food. The equipment at this point was distributed among the upper river stations, and the buildings were sold to the highest bidder. The principal centers of rescue work were Homer, Minn., La Crosse, Wis., Marquette and Bellevue, Iowa.

Favorable water conditions permitted the rescue crews to start operations early in August, 1921. As the water receded additional crews were placed at points between Prescott, Minn., and Bellevue, Iowa, and the work was prosecuted until stopped by freezing weather in November. At La Crosse, Bellevue, and Marquette retaining stations are used for holding fishes needed for distribution to applicants. At other points it has been found more economical to operate from specially constructed house boats, as the rescued fish

are placed immediately in the open waters, none being retained for shipment. The total number of fish rescued in the Mississippi River during the season was about 178,475,000, at a cost of approximately 14 cents per thousand. Cooperation in the work was received from the States of Minnesota, Wisconsin, Iowa, and Illinois.

DISTRIBUTION OF MOSQUITO-EATING FISHES.

At a number of the bureau's southern stations it has been found that the mosquito-eating fish *Gambusia affinis* can be obtained in large numbers for the mere cost of collecting them from the pools, and in some instances they have been reared in the same ponds with the food fishes. In response to requests from the American National Red Cross and various State health authorities, shipments of Gambusia have been made by express, those receiving them paying the transportation charges. On account of the great service rendered the public, the bureau has felt itself justified in meeting reasonable demands for this fish.

ALASKA FISHERIES SERVICE.

EXTENT OF THE ALASKA FISHERIES.

The noteworthy feature of the salmon industry in 1921 was the great decrease in operations, only 83 salmon canneries being operated, 2 of which were new plants, as against 146 in the preceding year. The reduction of activities was most marked in the southeast and central districts. The catch of red salmon in the western district exceeded that of the two years immediately preceding, while the catch of salmon in the southeast district was the smallest in 17 years. The market for the cheaper grades of salmon was unsatisfactory, and this together with the anticipated light run of salmon in the central and southeast districts was no doubt largely responsible for the great reduction in activity.

The catch of salmon in the Alaska fisheries in 1921 was 37,905,591 fish, of which 26,103,291 were red or sockeye salmon, 7,156,818 humpback or pink salmon, 2,636,901 chum or keta salmon, 1,182,205 coho or silver salmon, and 826,376 king or spring salmon. Apportioned by geographical districts the catch in southeast Alaska was 11,852,511 fish, central Alaska, 7,929,346 fish, and western Alaska, 18,123,734 fish. Comparing these figures with the returns for 1920, it appears that there was a net decrease of about 42 per cent; coho, chum, and humpback salmon were taken in less numbers and king and red salmon in greater numbers.

The canneries, which utilized the greater part of the salmon catch, numbered 83, a decrease of 63 from 1920. The pack of canned fish was 2,596,826 cases, with a market value of $19,632,744, a decrease of 1,832,637 cases and $15,970,056 from the previous year. The pack of red salmon was larger and that of all other species was smaller than in 1920.

Other salmon products were 2,814,800 pounds of mild-cured fish, valued at $608,218; 2,016,400 pounds of pickled fish, valued at $179,414; 1,506,074 pounds of frozen fish, valued at $127,442; 9,103,104 pounds of fresh fish, valued at $418,265; 18,533 pounds of

dried and smoked fish, valued at $2,479; 15,010 gallons of oil, valued at $4,102; and 464,000 pounds of fertilizer, valued at $13,920; giving $20,986,584 as the total value of the products of the Alaska salmon industry in 1921.

The halibut fishery ranks next to the salmon fishery, and in 1921 yielded 9,575,287 pounds of fresh fish, valued at $910,375; 7,599,097 pounds of frozen fish, valued at $565,915; and 1,890 pounds of cheeks and pickled fish, valued at $160.

Products of the herring fishery consisted of 14,523,441 pounds of Scotch-cured fish, valued at $838,335; 406,250 pounds of Norwegian-cured fish, valued at $20,433; 892,000 pounds of fertilizer, valued at $26,760; 84,938 gallons of oil, valued at $21,236; and 2,666,048 pounds of bait, valued at $27,280.

The cod fishery yielded a catch valued at $457,320. The products of the shrimp fishery were 344,986 pounds of fresh shrimp meat, valued at $132,077. Minor items were: Whales, $19,950; crabs, $33,180; trout, $18,925; sablefish, $17,985; clams, $9,940; red rockfish, $362; and smelts, $50.

The entire Alaska fishing industry, exclusive of fur sealing, gave employment to 15,070 persons, represented an investment of $39,001,874, and yielded products valued at $24,086,867.

A detailed account of the extent and condition of the Alaska fisheries in 1921 and of the activities of the bureau under the laws and regulations for the protection of the fisheries is embodied in the annual report of the Alaska service for that year.[2]

ENFORCEMENT OF FISHERY LAWS AND REGULATIONS.

Patrol of the fishing grounds in Alaska in 1921 was carried on with four bureau-owned and a number of chartered vessels. Three additional vessels were placed in commission by the bureau at the beginning of the fishing season of 1922, and a much larger number of small power boats are being made use of by stream guards and special employees. For the season of 1922 the persons engaged in connection with the enforcement of laws and regulations numbered 91, of whom 23 were regular and 68 were temporary employees. This is the largest force the bureau has ever put into the field.

A number of violations of the fishery laws occurred in 1921, being chiefly of four classes, fishing in streams or within the prohibited distances of the mouths of streams, fishing by aliens, wanton waste of salmon, and fishing during the weekly close period. Slightly over half of the cases were against natives, and over 80 per cent were brought in the southeast district. Convictions were obtained in 87½ per cent of the cases tried.

It is anticipated that the greatly increased force of stream guards employed in 1922, with more vessels for patrol, will have a deterrent effect on would-be violators. No doubt the knowledge that a bureau employee is stationed at the mouth of a stream will in most instances prevent any attempt at illegal fishing and thus with a minimum of annoyance and expense for prosecution the object of conservation of the fisheries will tend to be accomplished.

[2] Alaska Fishery and Fur-Seal Industries in 1921. By Ward T. Bower. (Bureau of Fisheries Document No. 933.)

Work of erecting markers near the mouths of salmon streams was carried on, those destroyed being replaced, additional streams marked, and old markers moved to conform to the closing order of December 30, 1921, which made the 500-yard prohibition applicable to all streams of southeast Alaska as well as of other districts.

A number of complaints have been made of the stealing of salmon from traps in southeast Alaska. Depredations of this character are regarded as outside the jurisdiction of the bureau, but assistance has been rendered to the officials of the Department of Justice, and transportation to its agents has been afforded on the bureau's vessels whenever possible in connection with efforts to suppress the practice. In the season of 1922 four vessels of the Navy Department were stationed in the southeast district to assist the Department of Justice, and Coast Guard cutters also took part in the work.

PRIVATE SALMON HATCHERIES.

The private salmon hatcheries in Alaska have been inspected as required by law. In 1922 two such hatcheries were operated. One of these, on Naha Stream, liberated 12,885,000 red-salmon fry in the fiscal year 1922, and the other, located on Hugh Smith Lake, liberated 9,647,000 red-salmon fry in the same period. The total rebate of taxes on canned salmon, at the rate of 40 cents per 1,000 fry released by these hatcheries, amounted to $9,012.80.

NEW SALMON-FISHERY REGULATIONS.

In accordance with announcements duly issued, hearings were held at Juneau on October 19 and at Seattle on November 15 and 17 for the consideration of necessary changes in the regulations regarding salmon fishing in Alaska. The waters affected were those of southeast Alaska and of the region from Cape Newenham north and eastward to the Canadian boundary. Statements were also permitted to be made by interested parties in regard to the Copper River, Kuskokwim River, and Yukon River, in which commercial fishing is prohibited. As a result of these hearings the following order was issued on December 30, 1921:

Hearings having been given, after due notice in accordance with law, for the purpose of determining the advisability of limiting or prohibiting fishing in certain waters in Alaska, and to amend or modify certain existing regulations, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter described waters of Alaska be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Salmon fishing is prohibited in all streams, within 500 yards of their mouths, and in their tributaries and lakes, except as hereinafter permitted.
2. Fishing is permitted at Karluk beyond the zone 100 yards outside the mouth of Karluk River where it breaks through Karluk Spit into Shelikof Strait.
3. Fishing is permitted in Ugashik River below a line extending at right angles across the Ugashik 500 yards below the mouth of King Salmon River.

4. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

5. This order does not apply to persons taking salmon by any lawful means for local human food requirements, or for use as dog feed.

6. The waters of the Afognak Reservation are covered by presidential proclamation of December 24, 1892, and the regulations promulgated by authority thereof are not modified or affected by this order but remain in full force.

7. All previous orders of the Secretary of Commerce imposing limitations or prohibitions upon fishing in the waters covered by this order are hereby superseded.

8. This order becomes effective January 1, 1922.

Under date of February 17, 1922, an Executive order was issued creating a reservation to be called the Alaska Peninsula Fisheries Reservation, extending eastward from the Aleutian Islands Reservation to a line from Foggy Cape on the eastern end of Sutwik Island to Cape Menshikof on the northern shore of the Alaska Peninsula, and including the Shumagin Islands and the territorial waters adjacent to these lands and also the lands of the Aleutian Islands Reservation. The text of the order follows:

In addition to the islands of the Aleutian chain, Alaska, withdrawn and made a preserve and breeding ground for native birds, for the propagation of reindeer and fur-bearing animals, and for the encouragement and development of fisheries, by the Executive order of March 3, 1913 (No. 1733), as modified by the Executive order of August 11, 1916 (No. 2442), a reservation comprising the islands, peninsulas, and lands adjoining the eastern end of the reservation established by the said Executive order of March 3, 1913, and extending in an easterly and northerly direction from Isanotski Strait to a line extending from low-water mark at Foggy Cape on the eastern end of Sutwik Island to low-water mark at Cape Menshikof on the northern shore of the Alaska Peninsula, including the Shumagin Islands and all other islands, peninsulas, or parts thereof within the described area is hereby set apart as a preserve to more effectively insure the protection of the fisheries and for their encouragement and development. This latter reservation is to be known as the Alaska Peninsula Fisheries Reservation.

It is hereby further ordered that all straits, bays, and other waters over which the United States has jurisdiction by reason of their relation and proximity to the islands, peninsulas, and other lands to which this order, as well as the said order of March 3, 1913, applies, be and the same are hereby reserved and set apart also as a preserve to more effectively insure the protection of the fisheries and for their encouragement and development.

The Secretary of Commerce shall have power to make regulations for the proper administration of the said Alaska Peninsula Fisheries Reservation, and the straits, bays, and other waters reserved by this Executive order.

The establishment of the reservations under this Executive order shall not interfere with the use of the waters, islands, or other lands for lighthouse, military, naval, or other public purposes, nor with the use of any of said islands or other lands under the laws of the United States for town-site purposes, mining purposes, or grazing of animals thereupon, under rules and regulations to be established by the Secretary of the Interior.

Under date of April 18, 1922, the Secretary of Commerce issued the following regulations for the administration of the Alaska Peninsula Fisheries Reservation, including the waters of the Aleutian Islands Reservation:

1. For purposes of administration the following six fishing districts are created:

(*a*) *Port Heiden district.*—Extends along the Bering Sea shores of the reservation from its eastern limit to the one hundred and sixtieth meridian of west longitude.

(*b*) *Port Moller district.*—Extends along the Bering Sea shores of the reservation from the one hundred and sixtieth meridian of west longitude to the

north entrance of Isanotski Strait (otherwise commonly known as False Pass), which forms its western boundary.

(*c*) *Ikatan district.*—Includes Isanotski Strait south of its northern entrance, and extends thence along the Pacific shore of the reservation eastward to the one hundred and sixty-first meridian of west longitude.

(*d*) *Shumagin district.*—Includes the Shumagin Islands and the mainland shores and islands of the Pacific side of the reservation from the one hundred and sixty-first to the one hundred and fifty-ninth meridian of west longitude.

(*e*) *Chignik district.*—Extends from the one hundred and fifty-ninth meridian of west longitude along the Pacific shores of the reservation to its eastern margin.

(*f*) *Aleutian Islands district.*—Waters over which the United States has jurisdiction from Isanotski Strait westward throughout the entire Aleutian Islands Reservation.

2. No individual or concern shall engage in the business of catching, canning, or preparing salmon, except for personal or family use and not for sale or barter, within the above-stated districts without first securing a permit from the Secretary of Commerce. Applications for annual permits shall be addressed on or before January 15 of each year to the Secretary of Commerce, Washington, D. C., and shall give full information on the following points: (*a*) Name and permanent address of person or corporation desiring permit; (*b*) character of business proposed, whether fishing, canning, salting, or otherwise curing fish; (*c*) character and extent of plant to be operated and its location; (*d*) method and extent of fishing proposed; (*e*) exact place or places where fishing is to be carried on; (*f*) number and kind of each class of fishing apparatus to be used; (*g*) number of cases of salmon to be packed (based upon 48 one-pound cans per case) or number of barrels of salmon to be salted or tierces of salmon to be mild cured; (*h*) when operations are to begin; (*i*) if application is for continuance of operations formerly conducted, the catch and pack of salmon by species and the amount of each class of gear operated in the next preceding season must be shown; (*j*) affidavit as to correctness of facts set forth in the application must be made by competent authority.

3. Permits will specify the amount of pack and the character and extent of fishing operations allowed.

4. Permits for the season of 1922 will be issued only to such individuals or concerns as are now operating within the reservation.

5. Permits will be valid only within the district for which issued.

6. Transportation of fresh salmon for canning, salting, or otherwise preserving will not be permitted from one fishing district to another, or outside the reservation.

7. These regulations do not apply to persons taking salmon with rod, hand line, or spear for their personal or family use and not for sale or barter.

8. These regulations will be subject to such annual revision by the Secretary of Commerce as may appear advisable in view of the investigation and the experience of the preceding season.

9. These regulations will be in full force and effect immediately from and after date of issue.

Ten formal permits were issued for the operation of established plants within the reservation, as follows:

No. 47.	P. E. Harris & Co	Ikatan district.
No. 48.	Joint permit to Pacific American Fisheries, Nelson Lagoon Packing Co., Phoenix Packing Co., and Fidalgo Island Packing Co	Port Moller district.
No. 49.	Everett Packing Co	Do.
No. 50.	Pacific American Fisheries	Ikatan district.
No. 51.	Do	Do.
No. 52.	Shumagin Packing Co	Shumagin district.
No. 53.	Northwestern Fisheries Co	Chignik district.
No 54.	Columbia River Packers' Association	Do.
No. 55.	Alaska Packers Association	Do.
No. 56.	George Albert	Port Heiden district.

A number of local residents have also been given informal authorization to catch and prepare small lots of salmon, as has been done heretofore.

SPECIAL STUDIES AND INVESTIGATIONS.

In the season of 1921 a rack was installed in Karluk River and the counting of red salmon passing through to the spawning grounds above was inaugurated. This work is being carried on again in 1922, and a similar experiment has been undertaken in the Chignik River. The data to be thus secured over a series of years in these streams will help to solve problems of great importance to the salmon industry of Alaska, chief among which are the ratio between catch and escapement that will safely maintain the run and the production of salmon under natural conditions from a known escapement.

An investigation of fishery conditions in the Alaska Peninsula Fisheries Reservation was undertaken in the spring of 1922 by a party under the direction of Dr. C. H. Gilbert, of Stanford University. Statistics of the runs of salmon will be secured, and general study and observation of spawning escapement and operations of the companies will be made as a basis for recommendations covering operations in succeeding years.

Statistics of the catch of salmon are also being collected by regular employees on all the chief fishing grounds in Alaska in order to afford more accurate data for the conservation of the industry.

The destruction of predatory fishes was carried on in 1921 by an expedition to Bristol Bay region during the early part of the season, after which attention was directed to patrol of the fishing grounds, and later a survey was made of spawning grounds. Similar work is being done in the season of 1922.

PROTECTION OF WALRUS AND SEA LIONS.

No changes were made during the year in the walrus and sea-lion regulations issued April 21, 1921, nor were any violations reported.

NEW LEGISLATION NEEDED.

It has been realized for a number of years that a revision of the act of June 26, 1906, covering the fisheries of Alaska, was urgently necessary. Year after year efforts have been made to secure legislation that would be adequate to meet the new conditions that have developed and enable the department to exercise a proper control over the industry. The present law also refers wholly to the salmon fishery, with practically no application to the important industries that have grown up in the halibut, herring, cod, whale, shrimp, crab, and clam fisheries.

Under the authority granted to the Secretary of Commerce by the act of June 26, 1906, commercial fishing has been prohibited in practically all of the waters of Alaska over which the department has jurisdiction. It is unfortunate, however, that jurisdiction extends only over a zone 500 yards off the mouth of salmon streams, for outside of these waters with modern fishing appliances salmon can be taken with impunity, and practically without any control by the department's representatives, in such a manner as to catch far more than a safe proportion of the run. The results have been the steady and cumulative depletion of the finest fishing localities in Alaska,

and yet the department is powerless to prevent it under the terms of the present law. No authority is given to the Secretary of Commerce to limit the number of plants in a given area or the amount of gear that may be operated by them. In some instances by voluntary agreement those engaged in the industry have limited their packs, basing this action upon information compiled by the bureau showing the critical condition of the fisheries in those sections, but in other cases the shortsighted policy of certain operators prevents a full appreciation of the actual condition of the industry and to an extent nullifies the efforts of the bureau.

Following studies that had been made in 1921 and preceding seasons, the Secretary of Commerce called a conference in November at which Members of Congress, representatives of the salmon industry, the Territorial government of Alaska, the Bureau of Fisheries, and others were present for the consideration of the needs of the fisheries of Alaska and action to be taken for their conservation. As a result of the conference a bill was drafted. A hearing was held before the Committee on the Merchant Marine and Fisheries on H. R. 2394, known as the White bill, then pending in Congress, at which representatives of the fishing industry of Alaska and of the Territorial Fish Commission were present and recommended the substitution for the White bill of the bill prepared following the conference called by the Secretary. Opposition to certain provisions of the substitute bill developed, and it was never introduced. The White bill is still pending in Congress.

The serious depletion of the salmon runs, which has occurred in certain parts of Alaska, has already caused the department to have recourse to the authority of the President for the creation of reserves within which a broader control could be had. It is now contemplated that further use of the powers of the Executive may be requested for the creation of a reserve to the northward and eastward of the Alaska Peninsula Fisheries Reservation covering the great red salmon districts of Bristol Bay and around Kodiak Island, and taking in Cook Inlet in central Alaska. Publicity is being given to these plans in order that the industry may be warned against undue expansions or new projects in the district, and the comments and suggestions of interested persons will be given due consideration.

A great deal of discussion has occurred for a number of years as to legislation needed for the conservation of the halibut industry. The halibut banks lie chiefly beyond the jurisdiction of the countries most interested, and it is realized that efficient protection can be given only through joint efforts of Canada and the United States. The department has submitted to the State Department information as to conditions and needs of this industry and has suggested that a treaty be negotiated with Canada to provide a close season of 90 days annually. It is hoped that this can be accomplished.

FUTURE DEVELOPMENT OF ALASKA FISHERIES.

Great development may be expected in some of the fisheries that have heretofore held minor places in the utilization of the aquatic resources of Alaska. The herring fishery made a record production in 1921 and would seem to offer the greatest possibilities

of exploitation. A representative of the bureau in Seattle was detailed to assist the small packers in securing supplies and by giving them valuable instruction as to trade requirements in Scotch-cure herring. Preparations have been made in 1922 for an unusually large pack, which will be prepared principally by the Scotch-cure method introduced by the bureau in 1917 and succeeding seasons through extensive demonstrations at all of the chief herring centers of Alaska. This expansion is due largely to the poor quality of herring that has been received from other sections of the country, which has stimulated efforts of the Alaska packers to supply the ready market offered. Processes should also be developed whereby the small herring can be packed in tin and made a valuable source of food. It seems not beyond the bounds of probability that the herring industry of Alaska may some day rival the salmon industry in importance. Another industry of growing importance, particularly in the southeast district, is the shrimp fishery. The crab fishery also showed a promising development in 1921.

ALASKA FUR-SEAL SERVICE.

GENERAL ACTIVITIES AT THE PRIBILOF ISLANDS.

The administration of the Pribilof Islands, including the supervision and care of the native inhabitants and the carrying on of operations connected with the valuable fur-seal and blue-fox herds, is steadily growing in importance among the activities of the bureau. The size of the herds of both fur seals and foxes and the large financial return to the Government, as well as the interest of foreign governments in the fur-seal herd, make this a business undertaking of considerable magnitude, requiring the best attention of technically trained and experienced administrators.

The work on the Pribilof Islands is carried on by the bureau's staff of about 15 white employees, with the assistance of the native inhabitants, numbering more than 300 persons. Remuneration for general services rendered by the natives is given in the form of subsistence, including food, fuel, clothing, and miscellaneous supplies, and living quarters, medical attention, and school facilities are furnished by the bureau. A dentist also was at the islands during practically the whole of the fiscal year 1922 for treatment of the natives. The workmen also receive cash payments for taking sealskins and fox skins and for certain other activities connected with the stations. In addition, from 40 to 50 native workmen from the Aleutian Islands are employed on St. Paul Island during the active sealing season.

Considerable construction work was completed during the year, particularly to provide facilities for washing and blubbering sealskins by the new method and to furnish necessary additional salt-house space. An electric-lighting system was installed and a concrete house for native use was completed on St. George Island. A large shop and a warehouse were also built on St. George Island for handling the increasing catch of fox skins. General repairs were made to buildings on both islands. Attempts by the Navy Department to drill an

artesian well on St. Paul Island were again unsuccessful. Work on laying out the water system in St. Paul village was continued, and if a supply of artesian water is not secured a series of shallow wells will be utilized or water piped from a pond at some distance from the village. The by-products plant was operated on St. Paul Island.

Transportation of supplies from the States to the Pribilof Islands was accomplished chiefly by the naval radio tender *Saturn*, but cargoes were also sent on the commercial vessels *Oregon*, *Brookdale*, and *Apollo*. Many courtesies in the transportation of passengers and small lots of supplies were also extended by the vessels of the Coast Guard.

The bureau's vessel *Eider* has rendered invaluable service during the year in the transportation of supplies, passengers, and mail between the Pribilofs and Unalaska, eight trips having been made. In addition the vessel went to Kodiak in September for extensive overhauling, returning to Unalaska in December. Three trips were also made to other islands in the Aleutian group to secure laborers for sealing work and to return them to their homes.

SEAL HERD.

The 1921 census of the seal herd, taken as of date of August 10, indicated 581,473 animals of all ages, an increase of 28,735 over 1920. The tentative figures for the census of 1922 gave 604,971 animals on the same date, an increase of about 23,518. The number of pups born in 1922 was 185,914. The seals killed from one census date to the next are not included in these figures. The 1922 enumeration was made by Edward C. Johnston, who also made the counts in the preceding year.

In 1921 two runways and towers were constructed to facilitate counting of seals, with such good results that in 1922 instructions were given for the construction of nine on St. Paul Island and one on St. George. Additional concrete markers were placed on the rookeries to separate the areas to be counted from the different tripods. Efforts were made to make as complete a pup count as possible in 1922, an undertaking that is becoming practically impossible because of the number of animals in the herd and the extent of ground covered by the rookeries.

The number of cows per harem in 1921 was 45; in 1922 the average was 52.19.

The matter of methods of taking the seal census and determining quotas of animals that may properly be killed for their skins has been receiving most careful consideration by the bureau. In line with the effort to secure all available information in regard to the life history of the fur seals, a party headed by the Assistant Secretary of Commerce is making a trip to the Pribilof Islands and other seal islands of the North Pacific Ocean in the summer of 1922 and will make careful studies of the herds at each locality.

Representatives of the bureau have authenticated 525 sealskins legally taken by Indians in the vicinity of Sitka, Alaska, during the spring migration of 1922. Indians also took 1,107 fur-seal skins off the coast of Washington, which were authenticated by the superintendent of the Neah Bay Indian Reservation under authorization

from the department. A patrol of the sealing grounds was maintained by the bureau's vessel *Murre.* Vessels of the Coast Guard carried out the usual extensive patrol during the migration from the waters off the coasts of Oregon and Washington, following the herd to the Bering Sea and patrolling waters adjacent to the Pribilof Islands and Aleutian Islands during the summer.

TAKE OF SEALSKINS.

The number of seals killed under governmental supervision on the Pribilof Islands in 1921 was 23,671, of which 22,560 were taken during the regular season ending August 5 and the remainder in the fall and winter. Seals 3 and 4 years old yielded 22,976 of the total number of skins secured.

The quota of seals to be killed during the calendar year 1922 was tentatively fixed at 25,000, all 3-year-old males. At the time of the visit of the Assistant Secretary's party to the Pribilofs in July the quota was increased to 30,000 3-year-old males, of which 25,000 were to be secured on St. Paul Island and 5,000 on St. George. Up to August 5, when killing ceased, 30,260 skins of all ages had been taken. Killings in the fall after October 20 will add a considerable number to this total.

As a result of experimental work carried on at St. Paul Island by representatives of the Fouke Fur Co. a large number of the skins taken are now handled by methods much changed from those formerly in use. In the past the pelts have been removed by the native workmen in the ordinary manner of skinning animals, which at times resulted in cuts or flays that lessened the market value of the skin. Under the new method the knife is used only to slit the skin along the abdomen and to cut around the head and flipper holes. The carcass is then pinned to the ground by means of an iron bar and the pelt is pulled off. The layer of blubber and meat that remains attached is removed when the skin is blubbered by a force of employees detailed from the dressing and dyeing company. The skins are then washed in running sea water and salted. Washing tanks and additional salthouse facilities have been provided to carry on this work.

SALES OF SEALSKINS.

In the fiscal year 1922 two public auction sales of fur-seal skins were held at St. Louis. At the sale on September 28, 1921, 10,778 skins brought $333,772, and on April 3, 1922, 12,198 skins were sold for $388,288, a total of 22,976 skins and $722,060. The better grades of skins brought slightly higher prices than in previous sales, but the large number of low-grade skins from the killing of surplus old males kept the average at practically the same as in the sales the preceding year.

At the sale on April 3, 1922, there were also sold 56 sealskins from the Japanese herd on Robben Island, representing the share of the United States in the skins taken in 1920. These 56 skins brought $1,276.

As a result of the sales of fur-seal skins from the Pribilof Islands in the fiscal year 1922 the sum of $94,634.16 has been paid to Great

Britain and Japan as their share of skins to which they are entitled under the North Pacific Sealing Convention of 1911.

FOXES AND REINDEER.

The herds of blue foxes on the Pribilof Islands maintain themselves naturally to a large extent on the refuse from seal killings and the thousands of sea birds that nest on the islands. Seal carcasses are also stored for feeding during the winter months. Since the resumption of commercial sealing the fox herds have steadily grown and are now a valuable asset to the Government. Foxing operations during the winter of 1921–22 yielded a total of 712 blue and 21 white pelts. Warm weather and high seas during the trapping season interfered seriously with the work, particularly on St. George Island, which has the largest herd, as so much food was available on the beaches that the animals did not come to the traps for food. Over 200 pairs of foxes were marked and released as breeders on St. George Island during the trapping season.

The fox skins taken in the season of 1920–21, numbering 1,125 blues and 14 whites, were sold at public auction in St. Louis September 28, 1921. The price realized was $109,398, an average of $96.83 for blue and $33 for white skins.

An arrangement was also made through the Bureau of Biological Survey for the sale of live blue foxes to natives of the Aleutian Islands for stocking fox farms. Four pairs were thus delivered in September, 1921, payment being made at the rate of $88.12 per animal, the average received at the last preceding sale of Pribilof fox skins in St. Louis.

The herds of reindeer on the Pribilof Islands have made satisfactory growth since their introduction in 1911. It was estimated at the end of the calendar year 1921 that there were 250 animals on St. Paul Island and 160 on St. George, a total of 410. In addition 53 were killed for food during the year, 19 of which were used on St. George Island.

COOPERATION WITH OTHER GOVERNMENT AGENCIES.

The International Committee on Marine Fishery Investigations held two meetings during the year, the first at Boston on November 4, 1921, attended by two representatives of Canada and two representatives of the United States, and the second in Montreal on May 26, 1922, attended by all representatives of the United States and Canada. On neither occasion was it possible for the representative of Newfoundland to be present. This committee, while engaging in no investigations on its own part, serves as a coordinating agency for the marine fishery investigations of the several countries. Through the discussions of work accomplished or in contemplation and the information and suggestions gained in meeting, it is possible for functioning agencies of the several Governments to plan and conduct investigations in a manner more productive of results and more helpful to all concerned.

As in the preceding years the bureau has cooperated with a number of other Government bureaus, as a result of which it has both re-

ceived and extended helpful service. Such relations have been maintained with several bureaus within the department. The Bureau of Standards has rendered assistance in the standardization of instruments and testing of materials under investigation by the bureau. Arrangements have been made with the Bureau of the Census for the collection and exchange of statistical data of the production of fish oils and fishery by-products that are of mutual interest. The Bureau of Foreign and Domestic Commerce has cooperated in the acquisition of information concerning the foreign trade in fishery products.

Through the Consular Service, Department of State, much valuable information has been received concerning the condition of the fisheries in foreign countries, interesting developments respecting them, and the markets for fishery products. Certain of these reports have made the basis for a forthcoming publication on the fish trade of Latin America.

Effective cooperation has been maintained with the National Park Service in the stocking of the streams of the national parks and with the Forest Service in like work in a number of the forest reservations. Through the helpful interest of the Forest Service a brook-trout egg-collecting station is being established in the White Mountain Forest Reservation, which will materially reduce the cost of supplying eggs to a number of the bureau hatcheries.

Helpful relations have been continued with the Bureau of Indian Affairs and the Reclamation Service, and the Geological Survey has assisted this bureau in several instances during the year.

A scientific assistant was detailed for work with the Public Health Service in connection with problems of mosquito control by fishes.

The bureau was indebted to the Navy Department for the transportation of the annual supplies to the Pribilof Islands and to the Coast Guard Service for aid on numerous occasions, particularly in connection with work in Alaska.

VESSEL SERVICE NOTES, 1922.

In view of the excessive cost of coal and other operating expenses and the difficulty in securing a trained civilian staff at the salaries available, it was decided to discontinue for the present any attempt to use the steamer *Albatross*. Accordingly she was taken to Woods Hole, Mass., and put out of commission October 29, 1921. The officers and men were detached for regular naval duty and the vessel placed in the custody of the superintendent of the Woods Hole (Mass.) station.

The hydrographic and biological survey of Chesapeake Bay has been completed as far as the steamer *Fish Hawk* is concerned, six round trips of the bay having been made during the fiscal year. The last one was completed May 24, and on June 7 the vessel arrived at Woods Hole, Mass., preparatory to undertaking similar survey of Long Island Sound. The first trip, which was in the nature of a reconnaissance, was begun on June 28. During the fiscal year the *Fish Hawk* steamed 3,181 miles.

No special work was required of the *Halcyon* except during about five months of the year. From July to October her headquarters were at Boothbay Harbor, Me., and for the remainder of the year

at Woods Hole, Mass. During August a cruise was made of 2,143 miles to obtain bottom samples in connection with the hydrographic survey of the Gulf of Maine. The run embraced Nantucket, Browns Bank, and Yarmouth; 118 stations were made. June was taken up with the preparation of appliances for current observations for the same investigation, and on June 30 the *Halcyon* sailed from Woods Hole to begin the work. During March and April the steamer and her crew were engaged in flatfish work at Newport for the Woods Hole (Mass.) station, but practically no cruising was required. In all, the vessel steamed 3,920 miles.

On account of lack of funds the *Phalarope* was operated to but a limited extent, and what little she did was in connection with the Woods Hole laboratory in August, 1921. During July, September, and October the crew was occupied in putting the *Fulmar* in shape and transferring her from Woods Hole to Charlevoix, Mich. The engineer has been detailed to Washington for special duty, and the remainder of the personnel to the Woods Hole (Mass.) station.

The *Gannet* was only required for use in connection with the Boothbay Harbor (Me.) station during March and April, while the flatfish work was going on. In that period, however, she cruised 2,865 miles in 52 days of actual operation. During the balance of the year her officers and crew were detailed to the Boothbay Harbor (Me.) station excepting for May and June, which were spent in overhauling and reconditioning the vessel.

The *Shearwater* is used for fish-cultural work on the Great Lakes, and during the last fiscal year she was only operated 31 days in the fall and 41 days in the spring. She steamed, however, 2,110 miles. There is no statutory crew provided for the vessel, and her operating costs are very reasonable.

The auxiliary schooner *Eider* made eight round trips between Unalaska and the Pribilofs for the purpose of carrying supplies and Government employees and three trips about the Aleutian Islands for other purposes connected with the bureau's work. During October and November the vessel was overhauled at Kodiak. During the year she cruised 6,965 miles.

The *Murre* and *Auklet* carried on the usual fisheries patrol in southeast Alaska during the summer of 1921, and in October were used by the fish-trap inspectors of the War Department. The *Murre* was also placed at the service of the Bureau of Education and Department of Justice in December and January. In February the *Auklet* towed the gas boat *Merganser* to Seattle, where a new engine was installed in the latter. The *Murre* and *Auklet* have both been equipped with 40-horsepower Standard engines, their original ones of 25 horsepower having proved too light.

The gas boats *Petrel* and *Merganser* were placed in the Alaska Fisheries Service the latter part of the fiscal year. During the winter the gas boat *Widgeon* was taken to Seattle from Norfolk on a Navy transport, and at the end of the year was being altered to suit the needs of the bureau. She will be used in southeast Alaska.

In April the purse seine boat *Clatsop* was purchased for $5,500 and was sent to Bristol Bay for patrol duty. Her name has been changed to *Scoter*.

APPROPRIATIONS.

The regular appropriations for the support of the bureau for the fiscal year 1922 aggregated $1,250,430, as follows:

Salaries	$444, 810
Pay, officers and crews of vessels for Alaska service	26, 000
Expenses of advisory committee	2, 500
Miscellaneous expenses:	
Administration	11, 000
Propagation of food fishes	400, 000
Maintenance of vessels	120, 000
Inquiry respecting food fishes	45, 000
Statistical inquiry	20, 000
Protecting sponge fisheries	3, 000
Protecting seal and salmon fisheries	165, 000
Protecting seal and salmon fisheries, deficiency	3, 750
Fish hatchery, Wyoming	10, 000
Total	1, 250, 430

In accordance with law a detailed statement of the expenditures will be submitted.

Respectfully submitted.

HENRY O'MALLEY,
Commissioner of Fisheries.

Hon. HERBERT HOOVER,
Secretary of Commerce.

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FRESH-WATER CRUSTACEA AS FOOD FOR YOUNG FISHES.[1]

By WILLIAM CONVERSE KENDALL, *Scientific Assistant, U. S. Bureau of Fisheries.*

CONTENTS.

INTRODUCTION.

Some years ago a number of species of small crustaceans were recommended as natural food for artificially raised young fishes, particularly salmon and trout. The claim was made that the ease with which certain species of these little animals could be kept and bred made them particularly valuable for fish-cultural purposes; but it was also suggested that natural streams and ponds deficient in food could be stocked with this kind of natural food, since some species

[1] Appendix I to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. 914.

were so common and of such wide distribution that a supply, as a rule, was conveniently available.

The principal advocates of the culture of crustaceans were European fish-culturists. In this country the idea had its supporters, although there were others who had no faith in it. The latter took the ground that while, owing to the small number of fishes raised, culture of crustaceans as food for young fishes was practicable in European establishments, in this country, where the business is conducted on a much larger scale, it would be impossible to maintain a sufficient supply to feed the fish.

There can be no doubt that these crustaceans would afford a most valuable food supply for young fishes if their culture should prove practicable on a scale to meet the demand, for some of the smaller kinds form, under natural conditions, the principal food of almost all species of young fishes and almost the entire food supply of some adult small species, which in turn form the food of some adult large species, the young of which subsist largely upon the crustaceans.

If a system of crustacean culture can be devised which will meet the demand of the fish-culturist and the fish farmer, it will be a boon of inestimable importance. This paper does not pretend to devise such a system, but by reviewing what has been done and by affording some information regarding the nature, distribution, and habitats of the little animals concerned, it is hoped that it may afford the foundation, or at least the corner stone, of the desired structure. Most of the information conveyed by this paper is derived from a few special works. The greater part of that pertaining to the habits of the lower forms is derived, sometimes verbatim, from Ward and Whipple's Fresh-Water Biology, in which the subject of Phyllopoda is treated by A. S. Pearse, of Cladocera by Edward A. Birge, of Copepoda by C. Dwight Marsh, of Ostracoda by R. W. Sharpe, and of Malacostraca by A. E. Ortmann. Most of the matter pertaining to the Amphipoda, belonging to the latter class, however, must be credited to George C. Embody.

A list of the publications to which reference is made and credit given is appended. The date corresponds to that in parentheses following the author's name in the text of this paper.

CRUSTACEA.

For convenience the crustaceans with which this paper is concerned may be classed as (1) Entomostraca and (2) Malacostraca.

ENTOMOSTRACA.

The Entomostraca are very small, and some are so very minute as to be quite invisible to the naked eye. They enter largely into the natural food supply of the youngest stages of various fishes and even adults of some fishes.

The entomostracan class is subdivided into three distinct groups, designated as follows: Branchiopoda, Ostracoda, and Copepoda. Branchiopod is a name derived from the fact that the little animals have respiratory organs or gills attached to their "feet." Branchiopoda comprise two groups, Phyllopoda and Cladocera which for our purposes will be treated separately.

PHYLLOPODA OR FAIRY SHRIMPS.

The Phyllopoda, or fairy shrimps, have not been definitely indicated as possible food for fishes, although they occur in every part of the world, being found from sea level up to more than 10,000 feet. The distribution of all species, however, is apt to be local and their occurrence irregular and uncertain. A certain pool may swarm with them, while they may be entirely absent from near-by pools. A particular species may be abundant one season and scarce or entirely absent for several years, or it may appear regularly season after season. The greater part of the North American species occur in the Great Plains. Several species of Eubranchippus, however, abound in the Central and Eastern States. Most phyllopods occur, often in great numbers, in small fresh-water pools such as are formed by spring rains. Pearse (1918a) relates an instance of nearly half a bushel of dead Apus bodies having been observed by him on the bottom of a shallow dried-up depression about 20 feet in diameter.

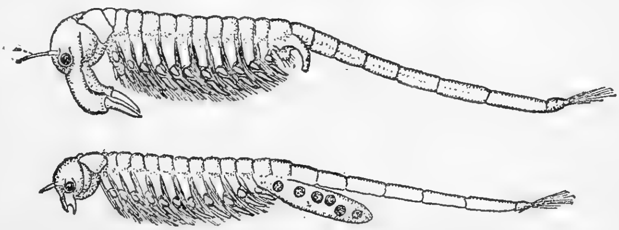

FIG. 1.—Fairy shrimp. *Branchinecta paludosa,* male and female. Enlarged three times. After Ward and Whipple.

The majority of phyllopods are very small, although one species of Apus attains a length of 70 mm. (something over 2.75 inches), but another species, a common fairy shrimp (*Eubranchippus vernalis*) grows to about 38 mm. (about 1.5 inches). The smallest species are inclosed in shells, in appearance suggesting tiny bivalve mollusks, and range in size from about 3 mm. (0.117 inch) to 16 mm. (about 0.669 inch) in length.

All phyllopods are of separate sexes and males are usually much less common than females. The eggs of most genera can resist prolonged desiccation; in fact it is apparently necessary for the development of some species that the eggs should first be dried and afterwards immersed in water. The mud of dried-up pools often contains large numbers of eggs which may be conveyed long distances by winds, birds, or other means. Many foreign species have been reared from dried mud brought home by travelers. Many eggs float when placed in water and development takes place at the surface.

CLADOCERA OR WATER FLEAS.

The most common of the branchiopods are the so-called water fleas belonging to the order Cladocera. These entomostracans have a wide distribution and some species are cosmopolitan. The majority of species found in this country are also found in Europe. They may occur in various sorts of environment. Some species are purely limnetic, some intermediate, some littoral, and others indifferent, that is, they may occur in any one of the environments. The cladocerans are plankton organisms abundant throughout the summer.

The food of these water fleas is mainly the lesser green algæ and diatoms, and their great importance in aquatic economy is largely due to the facts that they are herbivores and form the principal food of most young and small fishes, and that they reproduce at an exceedingly rapid rate.

The reproduction of Cladocera is remarkable. At intervals of only a few days, during the summer, successive broods of eggs appear in the space on the back inclosed by the shell of the animal. These eggs develop without being fertilized, and produce females only. The eggs, which vary in number from 2 to 20 or more, according to the species, are deposited in a cavity, bounded by the top part of the valves and the upper side of the body, the so-called brood case. Here they develop and hatch in a form quite like the parent and are well grown before they are set free. Sooner or later true females and males are hatched from the eggs. These females produce only one or two eggs, which must be fertilized before they develop. The rapidly developed young themselves soon reproduce.

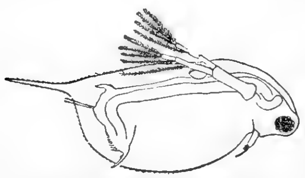

FIG. 2.—Daphnia; "water flea." *Daphnia pulex*, variety, male. Much enlarged.

There are many genera and species of cladocerans, but probably the best known and the most widely distributed are species of Daphnia, which occur in lakes, ponds, and pools in every region and are the forms which have been most commonly raised as food for young fishes and small aquarium fishes. The largest species is *Daphnia magna*, attaining a maximum length of from 2 mm. in males to 5 mm. in females (0.078 plus to 0.19 plus inch). The commonest species is probably *Daphnia pulex*, found everywhere. Its greatest size is 2.5 mm. (about 0.1 inch). These little animals have a great economic value. Together with the copepods, they constitute the chief agency for converting the smaller algæ of fresh water into forms edible by the carnivorous aquatic animals. They are the prey of insect larvæ, which are in turn an important item in the bill of fare of the larger fishes. The Cladocera themselves are of great importance as food for young fishes and, as previously stated, there is scarcely a fresh-water fish which does not subsist almost exclusively upon Entomostraca at some stage of its existence.

Mr. Atkins (1894) observed that, besides copepods, several species of daphnids were present in pools of Craigs Brook in the spring, even before the disappearance of ice.

Referring to observations on the occurrence of aquatic animal life during each day of the year ending October 31, 1893, in the northern part of Germany, Atkins stated that at the biological station at Lake Plön during every month of the year the presence, in abundance, of several species of Entomostraca was disclosed. From January to April, inclusive, there was the greatest scarcity, yet no less than seven species of Entomostraca were abundant in mid-January, and with the exception of the period from March 20 to April 10, there was no part of the entire year when some species was not found in abundance.

Mr. Atkins then went on to say that in the year 1873 he had occasion to note at Bucksport, Me., a phenomenon of like character with

those recorded at Plön. He had built a dam across a brook to obtain a head of water to use in a hatchery. The ground was part of an old pasture and cows waded freely about the brook and, for a time, in the small pond formed by the completion of the dam. A portion of ground thus flowed was a small alder swamp. Late the following winter there came down into the hatchery great numbers of living Entomostraca, mostly daphnids. At that time it was the practice to filter the water through a flannel screen set across the head of each trough, and so great was the number of Entomostraca that they often completely clogged up the screens, causing the water to overflow. This continued for several weeks. The pond was covered with ice all winter and the mean temperature of the water was as follows: In November, 39.1° F.; in December, 35.17° F.; in January, 34.5° F. Atkins remarked that whether these Entomostraca subsisted on their normal food (Protozoa) or not, it is evident that they found sufficient nourishment even in that very cold water, and the conclusion was warranted that daphnids might not only be bred in water cool enough for salmon and trout, but that they probably might be brought out at any season of the year by proper management.

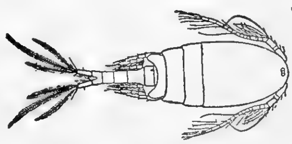

FIG. 3.—Copepod. *Cyclops capilliferus*, adult female. Enlarged.

COPEPODA.

The copepods are the perennial Entomostraca of open water. They are of extensive geographical distribution both in salt and fresh water and are present summer and winter. Deep lakes and shallow lakes have their characteristic copepod faunas, but this distinction does not rigidly hold, for frequently the species show a great deal of flexibility in adapting themselves to changed conditions. Excepting the few winter forms, the maximum numbers of any species occur in the months from May to September or early November. Sometimes there are two maxima, one in the spring and one in the fall (C. Dwight Marsh, 1918). Atkins (1894) stated that many copepods were found in early spring in very cool pools, sometimes in Craigs Brook, even anticipating the disappearance of the ice. They are small organisms, the different species varying in length of adults from about 0.5 to 4.5 mm. (0.019 to 0.17 inch).

The most common species of fresh-water copepods is *Canthocamptus minutus*, and it is found everywhere in the northern continents. *Cyclops leuckarti* is widespread and common. *Cyclops bicuspidatus* is the most common of limnetic species and is characteristic of the Great Lakes. *Cyclops viridis* is a widely distributed species occurring in pools, ponds, and lakes, and attains a length of 1.25 to 1.50 mm. (about 0.045 to 0.059 inch). Copepods feed upon animals, plankton, and algæ, especially diatoms. They are themselves important food for fishes, especially for young fishes.

OSTRACODA.

The ostracods are minute crustaceans, the head, body, and appendages of which are inclosed in bivalve shells, whence the name, meaning shell-like. They are exceedingly common and of extensive geographical distribution. Some are free-swimming, while others

live among water plants or in the ooze on the bottom. They may frequently be observed as swarming specks in pools where algæ and decaying plants abound.

The reproductive process and, therefore, the abundance of ostracods seem to be affected to a notable degree by the environment. The amount of light, the variations in temperature, the nature of the bottom, the presence or absence of algæ, the composition and rate of flow of water, all have their effects in one way or another. Direct or intense light accelerates all their life processes. Shady or dark areas in pools are not likely to contain certain free-swimming forms, while well-lighted places may contain them in abundance. Uniform distribution of light is conducive to a uniform distribution of these forms. On the other hand, the more stationary forms are more likely to occur in the deeper and darker places, in the ooze and slime of the bottom. However, some forms seem indifferent to whether it is light or dark, shallow or deep water. Unpolluted water appears to be essential to the well-being of the majority of forms, although practically no forms occur in spring water and running water is not especially favorable. Some forms are very tolerant of extreme stagnation and some seem even to favor stagnant water.

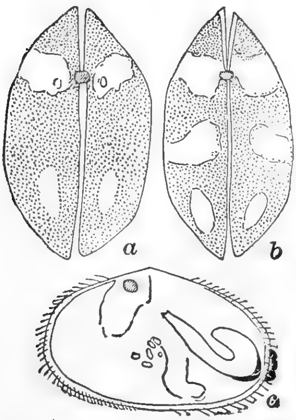

FIG. 4.—Ostracod. Two varieties. *Cypris fuscata.* *a* and *b*, dorsal views; *c*, side view of *a*. Enlarged 20 times. After Ward and Whipple.

Most ostracods subsist upon either animal or vegetable food, and small animals form a considerable portion of their diet. Some will eat their own kind if the opportunity offers. Some species have been observed skeletonizing leaves. It is stated that in captivity most forms will eat from thin slices of potato. Their great numbers and greediness oftentimes make them very efficient scavengers and effective agents in purifying standing water.

Most species of ostracods are bisexual, but a few are represented by females only, which reproduce by unfertilized eggs. Their eggs are said to have a remarkable vitality as do those of phyllopods and some Cladocera. An instance is on record of samples of mud being sent to England from Jerusalem and Entomostraca (Cypris and Daphnia) being raised from them after a lapse of from 24 to 30 years. G. O. Sars, of Norway, has reported raising them from dried mud sent him from Australia and China. Some species of ostracods may be found throughout the year in different degrees of development under the ice in winter. Mud collected from the bottom in winter and placed in water in a moderately warm place may very soon yield plenty of one or more species. Some forms occur only as summer forms, or from early spring to late autumn. The duration of life of the spring forms appears to be much shorter than that of the others.

The numerous species of ostracods vary in adult length from at least as low as 0.42 to as high as 3.60 mm. (about 0.016 to 0.14 inch). The most common North American ostracod is *Cypridopsis vidua*,

which varies in length from 0.60 to 0.70 mm. (about 0.023 to 0.027 inch) in length and is usually abundant whenever algæ are present. It is a free-swimming form, occurring below the surface.

Cypris virens, 1.7 to 2 mm. (about 0.065 to 0.078 inch) in length, is common in muddy ponds from April to July and occurs from Massachusetts to Mexico. *Cypris fuscata*, about 1.30 mm. (about 0.051 inch) long, is common everywhere in shallow grassy ponds and in swamps from April to June.

MALACOSTRACA.

This group of crustaceans comprises the generally larger forms and in fresh water falls into four distinct groups or orders: Isopoda, Amphipoda, Mysidacea, and Decapoda.

Fresh-water Malacostraca are found practically all over the world, excepting in the antarctic regions. The various forms are adapted to different surroundings, some preferring rivers, others creeks or ponds, or pools or springs.

The above-mentioned orders differ much in their superficial appearance—shape of body, size, color, and structure. All Malacostraca have separate sexes and propagation is by eggs. The different groups of Malacostraca differ greatly in their economic value, but all are of importance on account of the service rendered as scavengers and owing to the fact that they serve as food for other animals.

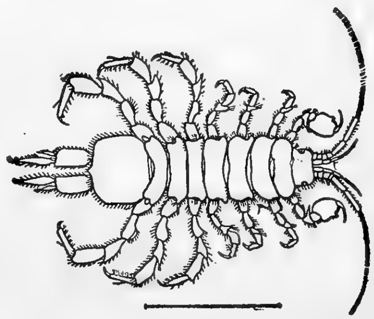

FIG. 5.—Isopod; "Asel." *Asellus communis*. Enlarged twice. After Ward and Whipple.

ISOPODA.

Isopods are represented by several species, one of the most common of which is *Asellus communis*, about 20 mm. (0.78 inch) in length, which is widely distributed, occurring in ponds, ditches, etc., and living among decaying vegetable matter. It is related to the common terrestrial sow bug or pill bug, to which superficially it bears but a remote resemblance. It feeds on water cress and other soft plants, living or dead, and to some extent on animal matter. It reproduces rapidly and, in spite of its cannibal habits when young, often becomes exceedingly abundant. An adult *Asellus communis* produces about 60 eggs at a time and carries them in a brood pouch, underneath her broad thorax, during incubation. There is a new brood every five or six weeks during the early summer season (Needham and Lloyd, 1916).

AMPHIPODA OR SCUDS.

The fresh-water amphipods or scuds are more commonly known as fresh-water shrimp or just shrimp, although various forms of the seashore and of brackish and sea water are more widely known as sand hopper, water fleas, sea fleas, etc. Some of the scuds are of wide distribution, the most common species being comprised in the genera Gammarus, Hyalella, and Eucrangonyx. The amphipods generally

vary greatly in the nature of their habitats, but while the three just mentioned differ somewhat in this respect, they are very similar in their habits. They are quick and active in their movements, their thoracic legs being adapted for climbing, and their abdominal appendages for swimming and jumping. They dart about among green water weeds, usually keeping well in shelter and swim rapidly when disturbed.

They are hardy and their habits enable them to maintain their numbers, although they are not as prolific as many other crustaceans. They carry their young in a pectoral brood pouch until well developed, and their agility and ability to conceal themselves serve to a considerable degree as protection against predacious enemies. Among the enemies of amphipods are fishes, birds, insects, Hydra, and the plant Utricularia. (Embody, 1911, states that amphipods are apparently able to escape by eating their way out of the "bladders" of Utricularia.

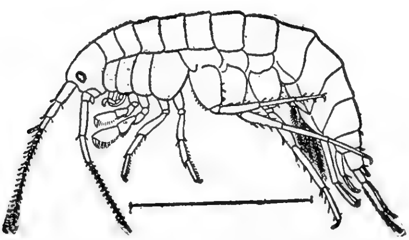

FIG. 6.—Amphipod; "scud"; Caledonia shrimp. *Gammarus limnæus.* Enlarged twice. After Ward and Whipple.

The food of the four species discussed in this paper is essentially the same for each species, consisting of living and dead animals and plants; but dead animal matter must not be much decomposed. Dead leaves and plant stalks are readily stripped of their softer tissues, and this material probably constitutes the larger portion of their natural food.

The North American species of most importance as food for fishes in fish-cutural establishments are *Gammarus fasciatus*, *Gammarus limnæus*, *Hyalella knickerbockeri*, and *Eucrangonyx gracilis.* There are, however, several species of amphipods besides the above which may be of considerable local importance and which would afford just as good, if not better, results in the particular localities as any of the above. The important amphipod of Europe which has received fish-cultural attention is *Gammarus pulex.*

Gammarus fasciatus.—This scud has a rather wide distribution, locally governed more or less by the character of the water. The U. S. National Museum records (1907) it from the Hudson River and Niagara Falls, N. Y.; Ann Arbor, Mich.; Lakes Superior, Delavan, and Geneva, Wis.; Havana, Ill.; Burlington, Iowa; Redfoot Lake, Tenn.; Brookside, W. Va.; Washington, D. C.; and St. Johns River, Fla.

In the vicinity of Ithaca, N. Y., Embody's observations (1911) indicated that it was restricted to Cayuga Lake and its open tributaries, but he stated that it seemed to occur most abundantly where vegetation was thickest and to be associated with thick masses of Massilea, Elodea, Potamogeton, Myriophyllum, and Utricularia. Warm water seemed to be no bar to its distribution, since it was found breeding in cove water where the temperature rose as high as 30° C. (86° F.).

The largest Cayuga specimen measured 15.3 mm. (0.60 inch). The average size of 16 egg-producing females was 8.73 plus mm. (0.34 inch), and the smallest of these, which was 39 days old and pro-

duced 6 eggs, was 5.8 mm. long. The average number of eggs produced by a female was 22, repeated at average intervals of 11 days. The breeding season of the species was from April 18 to November 3, a total of 199 days, when the temperature ranged from a minimum of 11.1° C. (51.98° F.) to a maximum of 30° C. (86° F.). It was calculated that the productive capacity of one pair and its progeny was 24,221. The young remained in the brood pouch an average of 2.25 days. The period from oviposition to hatching was 8 days at an average mean temperature of 23° C. (73.4° F.) and in 180 days from hatching the young grew from 1.53 mm. to 9.32 mm. in length.

Gammarus limnæus.—This is the "Caledonia shrimp" of early fish-cultural fame. Its general distribution is comparatively wide, occurring in certain characters of water. U. S. National Museum records (1907) are: Aroostook County, Me.; Caledonia, N. Y.; Marquette and Ann Arbor, Mich.; Isle Royal, Lake Superior; Fort Wingate, N. Mex.; Wasatch Mountains; Shoshone Falls, Idaho; Salt Lake City, Utah; Flathead Lake, Mont.; Yellowstone National Park.

Embody (1911) says it seems to occur in greatest numbers near headwaters of a brook and in its tributaries, and even in springs themselves. In the upper part of the brook the yearly range of temperature was from 6° to 12° C. (42.8° to 53.6° F.). The largest numbers of individuals were found associated with the roots of the water cress, thick tangles of Chara, and under decaying leaves. No individuals were found well down the brook where the water gave a temperature above 16° C. (60.8° F.) They were equally abundant in rapid and quiet water, in any place where there was sufficient accumulation of Chara, water cresses, and dead leaves, and where the water was sufficiently cool.

This species, according to Embody (1911), attains the largest size of the four species observed. The largest individual seen was 22.42 mm. (about 0.88 inch) long. The average size of 13 egg-producing females was 13.36 plus mm. (about 0.52 inch), and the smallest of these, which was 93 days old and yielded 8 eggs, was 9 mm. (about 0.35 inch) long. The average number of eggs produced by a female was 25, repeated seven times in the breeding season of 266 days, from January 8, 1909, to September 10, 1910. At this time the temperature ranged from 6° to 12° C. (42.8° to 53.6° F.), with average of 9° C. (48.2° F.) in 26 readings. The total reproductive capacity of one pair and its progeny during this season was calculated as 1,619. Observations upon two individuals gave the period from oviposition to the date of hatching as 18 and 21 days, the average mean daily temperature being 16.9° and 14.8° C. (62.42° and 58.64° F.), respectively, in February. The young remained in the brood pouch on an average of 3 days. In 180 days from hatching the young grew from 2.16 mm. to 11.73 mm. (about 0.085 to 0.46 inch) in length.

Hyalella knickerbockeri.—This form is one of the commonest fresh-water amphipods in the Eastern States. It has a very wide distribution, and in this country is found from Maine to Florida and California. The U. S. National Museum records (1907) are: Caribou, Me.; Cambridge and Quisset Pond, Mass.; Ann Arbor, Mich.; Isle Royal, Lake Superior, Wisconsin River, Lake Geneva,

Delavan, and Winnebago Lake, Wis.; Omaha, Nebr.; Urbana, Pekin, Clifton, Havana, McHenry County, Meredosia Lake, and Lake Michigan at South Chicago, Ill.; New Philadelphia and Tuscarawas River, Ohio; Piney Branch, D. C.; Point Pinellas, Fla.; San Marcos, Tex.; Lake Merced, Fresno, Los Angeles, West Berkeley, and San Francisco, Calif.; Yellowstone National Park; Volcan Reventado, Costa Rica.

Along with *Eucrangonyx gracilis*, Embody (1911) found it in the cold water of trout brooks as well as the warmest waters of Renwick Marsh; also in Cayuga Lake, Fall Creek, and the inlet both above and below the falls wherever there was any accumulation of living or dead vegetation. He said that in spite of the drying up of the marsh, the burning of the cat-tails and sedges, and the freezing of the ground to a depth of from 6 to 10 inches, both amphipods appear each spring in the usual large numbers in various marsh pools.

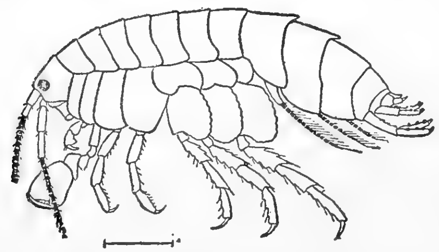

FIG. 7.—Amphipod; "scud;" "shrimp." *Hyalella knickerbockeri*. Enlarged 5 times. After Ward and Whipple.

The largest Hyalella observed by Embody measured 7.4 mm. (about 0.29 inch). The average length of 26 breeding females was 5.46 mm. (about 0.21 inch). The smallest egg-producing female measured 3.06 mm. (about 0.12 inch) and was 35 days old, producing 6 eggs. The average number of eggs produced at one time by the females observed was 18, which number was repeated on an average of 15 times in 152 days, in the breeding season embracing the months of April to September (April 2, 1910—September, 1909). At this time the temperature ranged from 7.8° to 30° C. (33.4° to 86° F.) with an average of 20.14° C. (68.252° F.) in 26 readings. Observation upon individuals gave the period from oviposition to the date of hatching as 8.5 and 8 days, the average temperature being 23.6° to 24° C. (74.48° and 75.2° F.), respectively, in July. The young remained in the brood pouch on an average of 2 days. The total reproductive capacity of one pair and its progeny in the period of 152 days was 13,976 in 4 generations. In 180 days from hatching, the young grew from 1.27 mm. to 6.4 mm. (0.05 to about 0.25 inch) in length.

Eucrangonyx gracilis.—Several species of Eucrangonyx are comparatively common in different parts of the country. The U. S. National Museum records (1907) are: Providence, R. I.; Ann Arbor, Mich.; Isle Royal, Lake Superior; Portage, Wis.; Champaign, Ill.; Irvington, Ind.; Delaware, Ohio; Nashville, Tenn.

Ortmann (1918) says they live in ponds, springs, and wells. Embody (1911) indicated that *E. gracilis* like Hyalella, with which he found it associated, was common under extreme conditions and variations of temperature from cold spring brooks to warm stagnant marshes. Its habitat seems to be indentical with that of *Hyalella knickerbockeri*, and both it and Hyalella seemed to be unaffected by the freezing of the marsh to 6 or 10 inches, or the burning of the cat-tails and sedges.

The largest adult observed by Embody measured 11.47 mm. (about 0.45 inch). The average size of 31 egg-producing females was 8.05 plus mm. (about 0.31 inch). The smallest egg-producing female was 5.6 mm. (about 0.22 inch), and it was 497 days old and produced 25 eggs. The reproduction period for the species embraced the months from January 8 to November 3, a period of 299 days, during which time the range in temperature was from a minimum of 6° to a maximum of 30° C. (42.8° to 86° F.). Eight days constituted the period from oviposition to hatching, average temperature for the time being 23° C. (73.4° F.). The calculated progeny from one pair, producing an average of 45 eggs at one time, breeding approximately 19 times, is 855 in 299 days. A second generation is not produced in the same breeding season. The young are carried in the brood sack on an average of 4 days, and in 180 days from hatching grow from 1.27 mm. to 3.57 mm. (0.05 to about 0.14 inch).

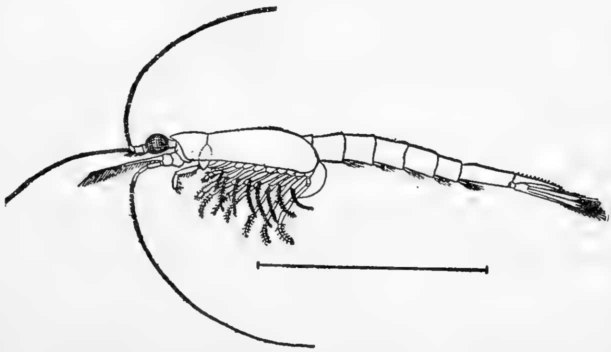

FIG. 8.—Mysis; "shrimp." *Mysis relicta.* Enlarged twice. After Ward and Whipple.

In this connection it would seem worth while to refer to a species of Eucrangonyx described as new by Embody in 1910. He called it *Eucrangonyx serratus* and stated that the type specimens were collected in March, 1908, from marginal vegetation of a "railroad pond," in Virginia, about 1½ miles north of Ashland. They were said to be especially abundant in the thickest patches of sphagnum and Utricularia at depths varying from a few inches to 1½ feet. Associated with them were large numbers of *Eucrangonyx gracilis* and *Hyalella knickerbockeri.* The pond in which they lived in such great abundance was described as having an area of about 30 acres and was said to be fed by springs within the pond itself and by a small brook at the end. It was found that the fish of the pond fed upon the amphipods liberally. The fish were largemouth black bass (*Micropterus salmoides*), common sunfish (*Lepomis gibbosus*), and calico bass (*Pomoxis sparoides*). The sunfish and calico bass, 1 to 3 inches long, some of which were able to penetrate the thick masses of sphagnum which harbored the amphipods in great numbers, were observed to be relatively the greatest amphipod devourers. This dense fringe of vegetation about the pond at all seasons, together with the rather large productive capacity of the species in question, prevented any very serious reduction of the numbers of crustaceans.

MYSIDACEA.

Very few Mysidacea are known from the fresh water, and the only species known in North America is *Mysis relicta,* which is considered identical with a species living in lakes in northern Europe (Ireland,

Scandinavia, and Russia). It is found in North America, under similar conditions, in Lakes Superior and Michigan, down to a considerable depth (150 fathoms). It is a delicate transparent creature, about half an inch in length.

DECAPODA.

The principal fresh-water crustaceans comprised in this group of particular cultural interest as fish food are the prawns and crayfishes.

Prawn.—Of the prawns Palæmonetes is the most important. Two species, *Palæmonetes paludosa* and *P. exilipes*, both from North Carolina, have been described but are now considered identical. Palæmonetes has been recorded from Florida, the Illinois River, and Lake Erie.

For the purposes of this paper the most important contribution to the knowledge of the fresh-water prawn, which is locally known as shrimp, is by Worth (1908). Worth calls it the true shrimp and says it is indigenous to the coastal plain region of North Carolina. It is the smallest of fresh-water decapods. It was stated that 136 to 140 individuals were counted to a fluid ounce, from which it was calculated that there were about 2,200 in a pint, as taken in early fall, young and old, with no culling. It is exceedingly abundant, "living in masses amongst water mosses and grasses," which in North Carolina are practically universal on all bottoms. It abounds in creeks, mill ponds, or lakelets formed by river overflow, or in pits along railroad lines where earth for embankments has been obtained. In the latter the shrimp is landlocked and dependent upon rainfall for its water supply. These holes, from 2 to 8 inches deep, are unshaded and subjected to extremes of heat and cold, the temperature ranging from 10° to approximately 100° F. In summer the water even exceeds 100°, and in the severest winters it freezes several inches thick. The overflows from the Roanoke River, from a clay country, are exceedingly turbid, but seem to have no deleterious effect upon the crustaceans. Instead of hibernating or burrowing during freezing weather, the shrimp appears merely to seek depth of water. It can not swim against a strong current.

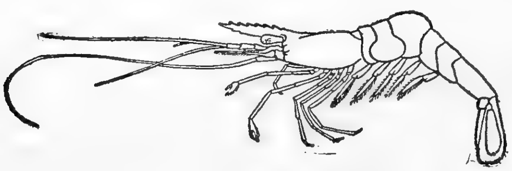

FIG. 9.—Prawn; "shrimp." *Palæmonetes exilipes*. Natural size. After Ward and Whipple.

Crayfishes.—The crayfishes or crawfishes are the commonest inland representatives of Decapoda. The rather numerous species of Europe and North America are comprised in two genera. Potamobius includes the European crayfishes and the five species of Pacific slope of North America from California to British Columbia. Cambarus is restricted to North America east of the Rocky Mountains, Mexico, Guatemala, and Cuba. It contains between 70 and 80 species.

Crayfishes live in rivers, ponds, lakes, sloughs, etc., and some are more or less terrestrial and some subterranean, living in cave waters. They are mainly carnivorous, their food being smaller animals, dead or alive, but southward an omnivorous species makes serious depredations on newly planted fields of corn and cotton. A burrowing

form has at times caused considerable damage to the Mississippi dikes. The different species vary much in size, many of them being large enough to be actually of considerable commercial importance. The smaller purely aquatic species form an important food for several species of fishes, and Hankinson (1908) reports that they "form a very important, if not the chief, food of the black bass, rock bass, and perch," in Walnut Lake, Mich. It is a favorite bait for the small-mouth black bass in Lake Erie, at least locally. The eggs of crayfishes are carried during incubation attached to the swimmerets of the abdomen, and the young are of the form of the adult, when hatched. They cling for a time after hatching to the hairs of the swimmerets by means of their little upper feet, and are carried about by the mother crayfish.

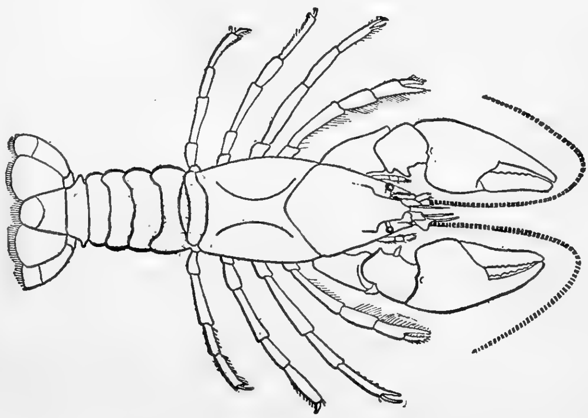

FIG. 10.—Crayfish; "crawfish;" "crab." *Cambarus bartoni.* Natural size. After Ward and Whipple.

POSSIBILITY OF SUCCESSFUL CRUSTACEAN CULTURE.

Various persons have advocated the culture of crustaceans as food for fishes, particularly young fishes, and have regarded it as a practicable procedure. Such pronouncements have been based upon both experiment and theory. The reports concerning European practices of years ago indicated that they were to a certain extent successful. Information indicating to what extent the success has been maintained or the methods improved is not at present available. In those early days American fish-culturists who advocated the same procedure in this country based their confidence in the practice upon the success attained in Europe. Some, claiming to have tried the methods, were enthusiastic in praise of the methods and the results obtained. One fish-culturist at least doubted the practicability of raising the crustaceans on a scale to meet the demands in this country. The enthusiasm and special efforts to raise crustaceans seem finally to have died out, thus in a way supporting the contention of fish-culturists of adverse views. In more recent years in this country the question occasionally arises, but principally among those who base their views partly, at least, upon the reproductive capacity of various species. A few observations have been made with feasibility of culture in view.

Actual observations in this direction are valuable, as they yield scientific data. By correlating other data and known facts regarding conditions of environment, life processes, and competition, and considering possible unknown favorable and unfavorable factors, approximately correct conclusions may be reached regarding one

particular set of conditions. But all must be repeated more or less in another different set. To be regarded as successful, crustacean culture, as any other culture, must economically produce a supply to meet the requirements.

To state that a project is feasible is one thing; to demonstrate it is another. To what extent success has been attained in the culture of any of the forms of crustaceans, and perhaps to some extent the possibilities of the culture of some forms in this country, will appear in the discussion which follows, in which the subject of culture of crustaceans will be taken up in the same order in which the classes were previously discussed: Entomostraca (Branchiopoda; namely, Phyllopoda and Cladocera, here treated separately; Copepoda; and Ostracoda) and Malacostraca (Isopoda, Amphipoda, Mysidacea, and Decapoda).

ENTOMOSTRACA.

PHYLLOPODA.

Culture or artificial use of Phyllopoda as fish food is mentioned by no fish-culturist. While these crustaceans are temporarily abundant, their occurrence is usually so irregular and uncertain that no dependence could be put upon them for anything like a permanent supply. When available, use might be made of them as a collateral supply. They would thrive in small inclosures which may be employed for raising Entomostraca. In fact it is quite possible that such inclosures might become naturally stocked. In any event fairy shrimp are only incidental possibilities of the augmentation of crustacean food supply for the fishes.

CLADOCERA.

While the food recommended for young fry is usually indefinitely designated as Entomostraca, about every specific citation is of Daphnia. *Daphnia pulex* is one of the most common forms and is the one specifically mentioned as in use at Gremaz (Ain), France (a noted fish-farming region). It has been calculated that the possible progeny of a single female might reach the astonishing figure of 13,000,000,000. However, in considering the possible capacity of the same female for fish-food production many adverse factors must be taken into account.

The most successful method of raising Daphnia and feeding young trout at the Gremaz establishment, according to C. Raveret-Wattell (1887), was to raise the crustaceans in the same inclosures in which it was intended that young fish should feed. The "basin" was first stocked with Daphnia and the stock allowed about a month in which to multiply. The young fish were then put into this inclosure, where they were said to find abundance of food. While this stock of food was being consumed another similar inclosure was prepared and abundantly stocked with Daphnia, which also were allowed a month for increase, when the fish were transferred to this inclosure, having eaten about all of the food of the first place. A month later transfer of the fish was made to the first inclosure, which had been restocked

with crustaceans, and so on. It was stated that this method was extremely simple and convenient.

Concerning the raising of Entomostraca, Seal (1892) wrote that stagnant waters everywhere, and especially those destitute of fishes, abound with certain kinds of Entomostraca, but principally with Daphnia and Cyclops. Water-cress beds and masses of other aquatic plants are alive with other kinds of crustaceans, such as "water hog" or "Asel" (Asellus), and "fresh-water shrimp" (Gammarus). Masses of dead leaves in the waters of springs or spring streams harbor them in great numbers. But the conditions in nature that promote their development are not nearly so favorable as they can be made by combining the natural and artificial. There is no necessity for the introduction of any foreign material to stimulate a production of the crustaceans. It appears that in raising Entomostraca at the Gremaz establishment secrecy was maintained and nothing was revealed concerning some essential principle. This secret was offered for sale. Mather (1897) stated that it was some system of ordure in which he had no faith. Evidently referring to the Gremaz method, previously mentioned, Seal went on to say that there was no necessity for driving fish from one pond to another, as the food could easily be caught and transferred to the fish basins. Seal suggested spreading the water from a spring so as to make a shallow pond and planting it thickly with water cress, stating that nature would speedily stock it with animal life.

The foregoing remarks by Seal would seem to apply more particularly to conditions suited to the scuds (Gammarus) rather than to Daphnia. However, he added that the advantage of an artificial system over purely natural conditions in the production of Crustacea is the same as in the propagation of fish, saying that when exposed to the ravages of fish themselves, the multiplication of the crustaceans would be slow, if not wholly averted, owing to the destruction of the breeders as well as the others. In separate basins, however, there would be no restriction on the production and "their fecundity is so great, the accumulation is enormous." "Thus," he says, "while one basin is being depopulated others can be repopulated." As at first a more extensive but in the long run most economical provision for raising Entomostraca (and probably other crustaceans), Seal suggested making wood or cement-lined trenches, covered with "sash like hotbeds," through which the waters of springs could flow, the inlets and outlets to be protected by wire gauze.

Raveret-Wattel (1898) described the methods of raising Entomostraca at a small fish-cultural establishment at Rouen, France. The fish-cultural operations were limited to 2,000 or 3,000 fry and the number of older individuals that resulted from that many fry. The fry were fed for a while exclusively upon Daphnia and other Entomostraca incidentally present. The entomostracan food was then gradually replaced by finely minced horse meat. A sufficient supply of Daphnia was maintained as follows: A cask was filled with water in which a light basket weighted with rocks and containing some stable manure, from which all straw had been removed, was sunk. Some Daphnia were then introduced, which in a little while multiplied sufficiently to provide a constant supply for the fry.

In a paper[2] read at the American Fisheries Society in 1918, Austin F. Shira, then director of the Fairport station, described some experiments which he had conducted relative to the possibility of satisfactorily raising Crustacea as food for young fishes. He stated that at Fairport the fish ponds are fed by Mississippi River water and that in the spring and early summer there is always an influx of Entomostraca which for a time affords an ample food supply for the young fishes, but that it is soon reduced considerably by the fishes. His experiments with Daphnia revealed that a single individual gave birth to three broods, and individuals from two of these broods each reproduced three times, making in all 143 progeny within 32 days after the experiment was started. From this data he calculated that if all the individuals in two generations produced as many young as the first individual cited, the possible number of young from all individuals would have been 1,595 from March 13 to April 12. There is a considerable element of uncertainty in this calculation. However, apparently basing his conclusions upon this calculation, Shira states that by reserving small concrete or earth ponds for the production of these forms an abundant food supply would be available for a considerable portion of the year, and the pond would be well stocked with winter eggs for the next season.

COPEPODA.

The use of Copepoda as fish-cultural food supply is perhaps implied in the recommendations for the use of Entomostraca, and Cyclops is occasionally definitely mentioned as suitable food for young trout. Some species of copepods could doubtless be raised at certain times of the year, if not alone, in conjunction with some other Crustacea. Some of the free-swimming species would probably be the most easily available, particularly in winter or early spring. The character of the waters in which they are to be kept may be determined by that of the water from which they are obtained.

From the foregoing discussion of the habitats and habits of copepods it is inferred that such waters as would be favorable to Hyalella would be suitable for some species of free-swimming copepods.

OSTRACODA.

The use of ostracods as food for young fishes has not been definitely mentioned, although it may be implied in the term Entomostraca. It is quite possible to obtain a stock of these little crustaceans from relict pools in a dry summer, when such pools are likely to swarm with them. It would not be necessary, in fact it might not be possible, to secure and maintain a pure colony of ostracods. If not taken with the ostracods, other forms of Entomostraca would probably gain access to the inclosures, provided the culture of the ostracods is on an adequate scale in tanks or outside ponds fed by surface water. Ostracods may be taken in sufficient quantities to form a large initial stock by using a dip net of cheesecloth or bolting cloth in the pools which contain them.

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[2] Unpublished manuscript.

MALACOSTRACA.

ISOPODA.

The Asellus, while fairly common at times and in places, compared with some other crustaceans is not abundant. It doubtless enters more or less into all open crustacean culture inclosures fed by surface water. Its habits do not render it particularly desirable, although it is in itself a good fish food for fishes large enough to swallow it. No special effort to cultivate it has been suggested.

AMPHIPODA.

Of all the crustaceans, the amphipods, or scuds, inappropriately called shrimp, have been most strongly advocated and most commonly used as food for young fish, particularly those which have attained the fingerling stage at fish-cultural establishments. The common amphipod of Europe which has been thus employed is *Gammarus pulex* (*pulex* meaning flea).

Raveret-Watell (1887) stated that at Gremaz arrangements were also made for raising amphipods. Alongside the fish ponds artificial rivulets were filled with water cresses and other aquatic plants and stocked with these crustaceans. However, the fish were not placed in these rivulets or ditches to feed, but the crustaceans were rationed out to the fish in their own inclosures. A sufficient quantity of "shrimp" was gathered in a few minutes to supply the fish with the amount of food required. It was said that when being fed the young trout would come from all directions "in dense masses" and would not allow a single "shrimp" to reach the bottom of the pond, and that no matter how large the quantity of shrimp it quickly vanished. It was claimed that the young trout thrived admirably upon the diet.

It was stated, also, that these small "shrimp streams" were so profitable that they would soon give place to a still simpler method, i. e., by proceeding in exactly the same manner as employed with Daphnia (alternately stocking and admitting fish to different inclosures). There were said to be 3 ponds ("basins"), each having a surface of about 120 m. and containing about 70,000 fish of the year, grouped according to size. It was stated that experiment had determined that one basin 35 m. (114.8 feet) long and 3 m. (9.84 feet) broad, with an average depth of 40 cm. (1.3 feet) of water, may contain 20,000 young fish from 8 to 12 months old, or 3,000 two-year-old trout having an average weight of 250 gm. (0.55 pound). Regarding the amount required, it had been determined that 10 kg. (about 22 pounds) of "shrimp" per diem, or 300 kg. (about 660 pounds) a month, would suffice for the fish; and that inclosures of the above dimensions would produce 300 to 350 kg. (660 to 770 pounds) of shrimp without at all interfering with Daphnia, Nais, Limnea, insect larvæ, etc., which were incidental or secondary products of the shrimp culture. It was said that it was necessary to have only two ponds for each lot of fish and to transfer the fish back and forth once a month.

Later Consul Frank H. Mason (1887) described the methods at the Gremaz establishment more fully than the preceding writer. He

said that it comprised a gently sloping piece of ground about 6 acres in extent, which was watered by three springs, collectively yielding about 500 gallons of water per minute. The fish-cultural basins were rectangular excavations about 120 feet long by 12 feet wide, with a depth of 5 feet. These inclosures were cement lined, owing to the gravelly character of the ground, in order to retain the water. The various basins had the same general level and were separated by sliding gates of wire gauze sufficiently fine to prevent the inter-passage of the fry. For each of these inclosures 20,000 yearlings or 3,000 two-year-old fish were considered sufficient. If the propagation of crustaceans was ordinarily successful, the 20,000 yearlings or 3,000 two-year-old trout would subsist royally for a month in a tank of the size indicated. They would eat on an average 20 to 25 pounds per diem, or 600 to 800 pounds in the month. Mr. Mason stated that each tank would produce 650 to 900 pounds of "Crevettes" (amphipods) to say nothing of Daphnia, Cyclops, and other species, simultaneously produced in the same inclosures. When at the end of the month the food of one tank had been depleted, a gate was opened and "the fish were driven like a flock of sheep to a new and similar pasture." The first tank was then closed and left quiet, while the process of self-replenishment of the stock immediately began. Again at the end of two or three weeks the water was swarming with the aforementioned organisms.

At an establishment in Spain operated by F. Muntadas (1887) no attempt was made to raise crustaceans as, it was said, a plenteous natural supply was always available. Muntadas wrote that ever since his first season he had used nothing but small "shrimp" for feeding his trout, which grew amazingly fast. However, in the large inclosures, the fish found, besides the myriads of small shrimp, tadpoles, gudgeons, and crawfish. The fish were stated to be very fond of crawfish especially in the shedding period. Some of the fish inclosures were referred to as stone basins, which produced on an average of 1,200 trout every year, while certain "open-air basins" contained young fish by the thousands. The young fish were said to remain in one place from March until September and were fed two or three times a day according to their needs. During the first two months the food consisted of assorted small shrimp. The daily quantity weighed 5 kg. (11 pounds). By carefully counting the number of shrimp in 5 g. (about one-sixth ounce) he found the number to be 672. The total number of shrimp fed to the fish in one day was, then, not less than 672,000, or 4,704,000 per week.

Referring to the use of crustaceans as fish food in England, A. N. Cheney (1892) quoted from a letter received by him from Thomas Andrews, of Guilford, "whose reputation as a successful fish propagator was broader than his native land." Mr. Andrews stated that he had made a specialty of natural food for his trout, devoting several boxes, 10 or 12 feet long, 6 feet wide, and 1 foot deep, besides several small ponds and side streams, to the purpose of raising *Gammarus pulex* mostly. He regarded young Gammarus as the best of food for 7-week-old trout fry. He raised large trout in ponds containing an extraordinary amount of natural food.

Von Marenzeller (1882) described in some detail a fish-cultural establishment in Germany owned by August Fruwirth. The young

fish (trout and saibling) were kept in small compartments and gradually admitted to larger ones. Connected with these were small shallow ponds of stagnating water, full of aquatic plants. These were for raising crustaceans as food for the young fish. They received their water from the same "canal" that supplied the larger fish pond, and from these food reservoirs the crustaceans were admitted to the compartments of young fish through "subterreanean wooden pipes" which could be closed. Thus, it was claimed, the young fish at the inland establishment were raised on exactly the same food as they eat in open waters. Mr. Fruwirth believed that the feeding of young trout and saibling with good and sufficient food, from the moment they lost the umbilical sac until the time when they could be fed on meat or fish, was really the point on which their rational culture depended, so crustacean food was supplied in unusually large quantities up to the end of the first year, after which he began feeding with horse meat.

Probably induced by the reported European success in crustacean culture, various fish-culturists in this country advocated a similar practice, and the subject was discussed at various meetings of the American Fisheries Society. During one of these discussions Mather (1897), having followed in his experiments, as he supposed, the methods employed at Gremaz and having met with unsatisfactory results, was skeptical regarding the practicability of crustacean culture in this country, where the yearling trout were raised in far greater numbers than in Europe. In discussing Mather's adverse statements, Mr. Thompson (Mather, 1897) stated that he had thousands of that year's trout from one-half to 2 inches long, and yearlings weighing from one-fourth to one-half pound, which had received no artificial food whatever, but had fed on crustaceans raised in a series of small natural ponds. Mr. Fairbanks (Mather, 1897), also discussing the subject, said that he had some 20 fine spring-fed, sidehill ponds, varying in size from 100 to 300 feet in length and 50 to 75 feet in width; also some smaller than these, about 100 feet in diameter. These ponds were planted with water plants and stocked with crustaceans. Into each of these stocked ponds 50,000 good, healthy fry were placed and never fed, touched, or looked at until they were yearlings. Some often grew to 6 inches in length. This he called a practical success, which was repeated year after year.

Embody (1911), in the introduction to his report upon his investigation of certain crustaceans, states that the studies were begun with the ultimate purpose of securing sufficient data to show the practicability or impracticability of propagating amphipods as food for fishes, and in the case of the former to determine which species would lend themselves most readily to such procedure. Embody's studies resulted in important determination of the distribution, habits, and life histories of four species of amphipods occurring in the region under investigation. While nothing definite regarding the practicability or impracticability of the culture of these forms is stated, that it would be practicable is perhaps implied in the last paragraph of his summary, in which he says:

> From its large size, rapid growth, and greatest reproductive capacity it is evident that *G. fasciatus* is likely to give the best results if propagated as food for fishes inhabiting the more open, quiet, and moderately warm waters.

As previously indicated, the other three species studied were *Gammarus limnæus*, *Eucrangonyx gracilis*, and *Hyalella knickerbockeri*, which are here named in the order of relative size from largest to smallest.

Embody shows that Eucrangonyx and Hyalella have the widest distribution and are adaptable to a wider range of temperature and other conditions than the other two species. According to Embody's observations, Eucrangonyx has the longest breeding period and Hyalella the shortest. *Gammarus limnæus* requires the coldest water for breeding. Eucrangonyx produces the largest average number of eggs, *G. limnæus* next, and Hyalella the lowest average. The young of Eucrangonyx grows slowly as compared with the other three species. Hyalella, next to *G. fasciatus*, has the greatest reproductive capacity, followed by *G. limnæus* and Eucrangonyx.

A logical deduction from the foregoing would seem to be that, taken all in all, Hyalella would be of the most general practicability and best suited to the most varied conditions and the greatest number of species of fishes. For Salmonidæ, however, particularly the eastern brook trout, *G. limnæus* would be the most suitable, for besides the possibility of raising it in waters cold enough for trout, next to Eucrangonyx it produces the largest number of eggs, and next to *G. fasciatus* has the greatest reproductive capacity. As has been previously stated, *G. limnæus* is the "Caledonia shrimp" of fish-cultural fame.

Shira,[3] by means of tables, gave the details of the partial reproductive capacity of one pair of Hyalellas, carried through 4 months. Assuming that the males and females of each brood were about equally divided, he calculated that the approximate possible number of progeny produced by the pair and succeeding generations was 339 in about 4 months' time. In another pen one pair produced 8 successive broods of a total of 122 young in 89 days, the shortest period between broods being 10 days. Shira's opinion, based upon his breeding experiments with Hyalella, was that it had been conclusively shown that the species could be reared in a practical way in large numbers as fish food. On April 29 a pond was supplied with water and aquatic plants, such as Ceratophylum, Philotria, and Potamogeton. The plants grew rapidly, and by the time the experiment had terminated had produced a very luxuriant growth. Breeding Hyalellas to the number of 2,583 were placed in this pond at intervals from May 12 to June 11. From June 15 to August 20 a total of 45,900 were removed and transferred to another pond. At the termination of the experiment an attempt was made to approximately estimate the number still remaining in the pond. A small lot was volumetrically measured and counted, and from the data thus derived it was calculated that the total number was 63,800. Adding to this the 45,900 which had been removed gives a total of 109,700 for the period. Shira thus says: "With a larger pond area and improvement of method, the possibilities of rearing this shrimp as fish food would seem unlimited." He states that the transfer of shrimp from one pond to another was the simple process of brushing through the vegetation with a small hand net of cheesecloth, by which means the shrimp were caught in large numbers.

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[3] Unpublished manuscript, 1918.

MYSIDACEA.

The Mysis would hardly seem of practical utility in fish-cultural establishments, as may be inferred from its known habitat and habits.

DECAPODA.

Prawn.—Worth (1908) regarded the prawn (*Palæmonetes paludosa*) as capable of broadcast artificial distribution and of becoming a resource of incalculable value. It was learned from trial that they could be sent long distances with little care, if properly prepared for shipment. It was found from experience, however, that the species quickly succumbed in overcrowding. A large loss resulted from such a cause in a shipment from Halifax, N. C., to Neosho, Mo. However, in 10 one-gallon tin pails having perforated covers, with 150 "shrimp" to a pail, and 10 similar pails with 180 to a pail, prawn were shipped from Halifax, N. C., to Washington, D. C., a distance of 200 miles. The total time before delivery was 19 hours, without icing, aerating, or other attention. From the 6,050 prawns sent the loss was only 2 per cent. Worth expressed the view that there was no doubt that *Palæmonetes* was entirely capable of being easily and cheaply multiplied, "requiring no better accommodations than a typical mosquito hole," in which its larger enemies such as fish do not occur.

Crayfishes.—It is not known that any attempt has been made to raise crayfishes as food for fishes, although Muntadas (1887) mentions them as present in his ponds and says that trout are fond of them. The smaller forms previously mentioned are far better adapted to the purpose and more easily raised. The fact that black bass and other adult fishes, even the trout, feed upon crayfishes when available suggests the question whether or not they might be raised in conjunction with the farm fishpond for the purpose of feeding the larger sizes and adults of certain fishes.

Commercial crayfish culture has been practiced with more or less success in Europe, but judging from the reports concerning these enterprises it would require quite as extensive plants to raise the crayfish as food for fishes as it would to raise the fishes themselves. It would be practically impossible to raise them in the same pond. Furthermore, the crayfish, while it is fairly prolific, produces but once a year at the most and is a slow growing creature. Moreover, the problem of its food supply is quite as difficult as is that of the fishes.

POSSIBILITY OF STOCKING STREAMS AND LAKES.

As the majority of streams and lakes probably contain or once contained before depletion some one or more forms of crustaceans, it would seem entirely practicable to add to the existing stock or to restock depleted waters, at least temporarily, by simple transfer of the organisms. The species which shall constitute the stock may be determined by the character of the water, the section of the country, and the availability of a supply. A near-by supply from similar character of water is desirable not only on account of convenience but because the species occurring there are the most likely to be

suited to the waters proposed to be stocked. However, some crustaceans, with reasonable care, may be shipped long distances.

Cheney (1892) stated that he had successfully transplanted "shrimp" in trout streams with the best of results, but had never tried them in ponds. Castalia Stream in Ohio was stocked with fish food by transplanting mosses and water weeds with accompanying insect and crustacean forms of life from Caledonia Creek in New York. When a can of this material was opened it swarmed to such an extent with these organisms that Prof. J. A. Lintner could not believe that it was a fair representative of the fauna of the creek.

That prawns can be transplanted has already been indicated by Worth (1908). Formerly Caledonia shrimp were quite extensively transplanted, with alleged success, into various lakes as well as streams. If it is possible to raise crustaceans of any kind in quantities to feed a large number of fish in fish-cultural establishments it should be possible to raise them on a scale to provide initial or occasional supplies for brooks, ponds, and lakes, particularly by State commissioners. However, as in the case of fish, the adaptibility of the crustacean to the water which it is proposed to stock should be ascertained.

As an example of stocking water with nonindigenous fish food, Cheney (1892) cited a lake 36 miles long and from 1 to 2½ miles wide in the State of New York that in 1878 was planted with 18,000 crayfish. The introduction was said to have been made in two or three streams at one end of the lake, with the result that in the several years past the crayfish occurred in abundance from one end to the other of this 36 miles of water.

METHODS OF OBTAINING STOCK OF CRUSTACEANS.

The only methods that have been suggested and the only ones that seem necessary for any kinds of the smaller crustaceans are fine meshed dip nets or small fine meshed seines. Seal stated that a breeding stock could be collected with comparative ease in stagnant and still waters almost anywhere, especially amongst water cress and other aquatic plants or masses of dead leaves. A cheesecloth net and a bucket would suffice for a collecting outfit, using the net amongst the plants and leaves, and depositing the crustaceans, as taken, in the bucket of water. These could then be transferred to a small pond, wood or concrete trench, in which aquatic plants had been thickly planted. He stated that enough food to raise one yearling trout could be produced within the limits of 1 cubic foot of water.

Muntadas (1887) secured enough "shrimp" from near-by natural waters to feed his trout, of which he stated that his basins contained thousands. The shrimps were gathered by means of a small net "attached to the end of a stick." The men who collected the crustaceans for him said that the supply was unlimited, "the more they took, the more there seemed to be."

Worth (1908) found it easy to catch prawn by means of a small hand net operated from the shore or from a small boat, and by the use of a small seine. He stated that 1,000 were gathered in 30 minutes at the rate of 900 per square rod, and with a 10-foot seine he collected 1,250 in three hauls.

VALUE OF CRUSTACEANS AS FISH FOOD.

Mr. Raveret-Wattell (1887) said of the fish raised at Gremaz that from their well-developed stomach and their finely rounded forms it could be seen that the fish had not only never suffered hunger but that they had always had abundant food of excellent quality. This crustacean food, he said, was exceedingly suitable for young fish on account of the large quantity of phosphate of lime which it contains, and this circumstance explained the rapid growth and exceptionally fine and vigorous condition of the young trout raised at Gremaz.

Mr. Mason (1887), after stating that the organisms thus raised and fed to the fishes at Gremaz far surpassed in value, as food for fish, anything that had been devised by man, enthusiastically continued:

> Thus the simple inexpensive process goes on from year to year, the fish always healthy and vigorous, and larger at 2 years old than those artificially fed are at 3 years. Yearlings bred in this way are strong and capable of making their way in any open stream or pond supplied with food and suitable for their existence. One thousand of such yearlings have been found more effective in stocking a depleted trout stream than 50,000 young fry turned in, as has been so often done heretofore.

Muntadas (1887) said that ever since his first season he had fed nothing but small shrimp to his young trout, "which grew amazingly fast."

Seal (1892) said that young trout in aquaria would always take Crustacea in preference to dead food, and that it was natural that they should.

Prof. Lintner, to whom Cheney (1892) had shipped Caledonia shrimp, had expressed the opinion that in time every order for 5,000 brook trout would be accompanied with an order for 100,000 shrimp. In the discussion of Cheney's paper (1892), Mr. Gilbert said that in his brook in Massachusetts the water cress and other aquatic plants were literally alive with fresh-water shrimp and that he did nothing to increase them. His trout fed on them all of the time, and in one place he had 20,000 yearlings.

Mather (1900) expresses his belief that Gammarus is greatly overrated as trout food. The stomachs of 247 trout from Wilmurt Lake, Herkimer County, N. Y., were examined by him and were estimated to contain but 5 per cent Gammarus. The same ration was found to obtain in 138 stomachs of trout taken from Meacham Lake, in the northern Adirondacks. He further stated that a trout of a pound weight seldom eats them.

Dr. Jousett de Bellesme (1895) said that in their efforts to produce an abundant supply of annual food for fishes certain specialists believed that the problem was solved by an unlimited supply of crustaceans. This was stated to be the system of Lugrin (at Gremaz), but that it had been demonstrated at the Trocadero Aquarium that feeding by means of Daphnia is simply a dangerous illusion, as these little animals possess very small value as food, and fish which are subjected to this régime do not grow.

Embody (1911) says that it is common knowledge that the eastern brook trout (*Salvelinus fontinalis*) feeds upon amphipods, and especially upon the so-called Caledonia shrimp (*G. limnæus*). Three young trout approximately 100 mm. long (3.93 inches) captured in

January had eaten five and seven large Caledonia shrimp, respectively, notwithstanding the great abundance of Hyalella and *E. gracilis* in the same stream.

Shira[4] states that Hyalella has been found to be a secondary host for one of the parasitic roundworms that infests the young of the smallmouth black bass. For that reason the feeding of this species to the bass is not to be recommended.

SYNOPSIS AND DISCUSSION.

Pearse (1918) stated that most fishes are not indiscriminate feeders, but that they select specific objects from the available food supply, that in some instances the powers of selecting and rejecting are remarkable, and that a perch may have its whole alimentary canal packed full of Daphnias, when the surrounding water contains Daphnia mixed with greater quantities of algæ. "Only the animal plankton is taken." He also cited the fact that young suckers are able to reject fine particles of silt, retaining only the food or organisms, and stated that even large adult perch often have nothing in their alimentary canal excepting great numbers of cladocerans.

The quantity of any food, particularly material found in the alimentary tracts of individual fishes, is not indicative of the amount necessary to sustain life, of the general supply, or even of the fish's preference. It is merely indicative of immediate availability. That perch have been found gorged with Daphnia or trout with other forms of Crustacea might be considered presumptive evidence of exclusive selection or discrimination, although it is quite possible that of the food ever utilized by the fishes it is the only form conveniently available at the time. It is a matter of common knowledge of those who have observed various fishes while feeding that any selection or rejection made is often after having taken the object into its mouth.

The fact that Mather (1900) found only 5 per cent crustaceans in the stomachs of certain individual trout does not indicate that those trout would not have eaten more, even to the exclusion of everything else, had they been able to get them. Nor does the fact that Embody's (1911) observations showed that certain trout had eaten a few *Gammarus limnæus*, while Eucrangonyx and Hyalella were also abundant in the brook, indicate a preference for that particular crustacean. Nor could the fact be regarded as positively demonstrating a power of discrimination, other than that produced perhaps by the larger and possibly more active, and therefore more conspicuous, Caledonia shrimp. Therefore absence, scarcity, or apparent discrimination exhibited by stomach contents in trout are, as a rule, no arguments against the use of crustaceans as trout food, for it has been shown that trout thrive and attain the pink of condition (literally and figuratively) upon food consisting largely of crustaceans.

On the other hand, what holds true for one species of fish might not for another. The fact that Pearse (1918) found a large black crappie containing 75 per cent pelagic entomostracans is no evidence that crappies could be fed exclusively upon Entomostraca. Pearse

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[4] Unpublished manuscript, 1918.

says that in considering fish foods and the feeding of fishes it is important to keep in mind that habits change with age. It is also quite evident that the feeding habits and food requirements of some species differ widely from those of other species, not only as they increase in size but even in the younger stages. Although it is recognized that entomostracans enter largely into the food of the young of many species and that there appears to be but little doubt regarding the high nutritive value of crustaceans, it has not been shown that crustaceans of any sort would be at all suitable as food for adults of every species of fish which has been cultivated.

No experiment or experience has proved that a permanent, constant, and exclusively crustacean food supply is desirable for all stages of any fish, even if practicable, and its practicability has not been demonstrated. None of the experiments in feeding artificially reared fishes with crustaceans has wholly eliminated other forms of food. As Pearse (1918) says, little is known concerning the amount and variety of food required for fishes, and he further pertinently remarks that the day when we shall know enough to figure out proper rations is far in the future and that in the meantime every effort should be made to provide better food for growing fishes. There is no reason why we should feed flour and liver forever without knowing why. Referring to the raising of trout on fly larvæ by Atkins[5] Pearse (1918) continues that there is no reason why other natural food should not be fed to growing fishes in hatcheries, adding that entomostracans are easily collected in quantities with pump or townet.

However desirable "natural foods" may be and however easily collected, the question of raising them is impossible of a solution of general practicable application. What might obtain in one locality or instance might not obtain in another locality or instance; what might suit one kind of fish might be entirely unsuited to another. For instance, it has been stated that one particular species of crustacean acts as a secondary host of a parasitic worm which infests smallmouth black bass. It is not known that any other species of fish is affected by this particular parasite, but the same sort of conditions may arise regarding other species of fishes and parasites.

In a proposition, then, of utilizing crustaceans as fish food in hatcheries, the question becomes specific and local and must be solved by the individual or institution concerned. However, this much is sure: Crustaceans can be cultivated in quantities. The local conditions and the kinds of crustaceans will largely determine the extent of operations in this direction. In their cultivation heretofore, while attention has been directed to one or two species, various other forms of crustaceans, insects, etc., have been coincident products. As respects possible undesirability of an exclusive crustacean diet, it may be said that a mixed diet is assured by the usual pond culture method. As heretofore, the culturist need pay special attention to only such forms as he wants for different ages of fishes. Other forms are likely to be present whether he wants them or not.

It has been seen that certain European fish-culturists, basing their conclusions upon actual operations, regarded the practicability of crustacean culture as successfully demonstrated, and for like reasons

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[5] Atkins, Charles G.: Foods for Young Salmonoid Fishes. Bulletin, U. S. Bureau of Fisheries, Vol. XXVIII, 1908 (1910), pp. 839–851. Washington.

certain Americans made the same claim. Later the subject was engaged from a biological standpoint. Recently Shira,[6] having calculated the possible reproductive capacity of certain forms, stated that to determine the possibilities of raising quantities of those organisms it was only necessary to multiply the number indicated as the average reproductive capacity by thousands. So, basing his conclusion upon the calculations and upon certain experiments in raising crustaceans, he pronounced the culture of Daphnia and "fresh-water" shrimp, in quantities to furnish an adequate supply of fish food, as perfectly feasible.

One of the reasons previously given by Embody (1911) for the selection of *Gammarus fasciatus* as the particular form likely to give the best results if propagated as fish food was its greatest reproductive capacity. Observations upon fecundity or calculations of possible reproductive capacity of crustaceans alone do not afford any basis for positive conclusions regarding the practicability of raising them, or the selection of species to be raised. Prolific offspring production in organisms indicates only a provision of nature for the perpetuation of the species, not the "geometrical progression" of the number of individuals. It is an adaptation tending to maintain a natural balance; in other words, an offset to adverse conditions which naturally beset the species. Expectancy of multiplication and duration of life of aggregations of offsprings can not be based upon the number of eggs or young produced without taking other factors into consideration. For instance, this expectancy is greatly reduced as respects organisms which are limited in powers of accommodation to changes of conditions and as applies to those forms which are eaten by other organisms or eat each other.

On the other hand, when favorable predominate over unfavorable conditions, the expectancy rises above normal in direct accord with the degree of predominance of favorable conditions. In the culture of crustaceans, then, it should be expected that the nearer the artificial conditions are to natural conditions the nearer will be the approach to a balance. The degree of removal of unfavorable conditions, or protection against them, and the degree of maintenance or increase of favorable conditions will determine the degree of increase in numbers and quality of the organisms. Even if an individual *Daphnia pulex* should, as has been calculated, produce 13,000,000,000 progeny in 60 days, the assumption is not warranted that there will be that many individuals at the end of 60 days to survive and breed in the next breeding period. The same may be said regarding the reproductive capacity of any of the other crustaceans. As previously indicated, any calculations based upon such figures alone yield no positive results, are mere mathematical gymnastics, and are more entertaining as curiosities of figures than of practical value. However, should it ever happen that a crustacean-raising establishment should be devised, whereby unfavorable conditions are greatly reduced or wholly eliminated, then the known reproductive capacity of the organisms in a given time would indicate which form would the most quickly yield the largest number, the approximate number of individuals that would have to be provided for, and the capacity of the rearing inclosures.

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[6] Unpublished manuscript, 1918.

It does not necessarily follow from the previously mentioned experiments, observations, and figures that crustaceans can be inexpensively raised in sufficient quantities to eliminate the necessity of other kinds of food at times. But whether or not any of the forms can be economically raised in sufficient quantities to exclusively afford a constant perennial diet for a large number of young fish in hatcheries, it would seem quite practicable to supplement other kinds of food with crustaceans, at a very moderate cost, or even to make crustaceans a temporary almost exclusive diet. Furthermore, it would seem that natural streams and ponds might have the fish-food supply increased by means of artificial stocking or transplanting.

At present some method of pond culture would seem most feasible for raising Crustacea. Shira[3] stated that at the Fairport ponds, which are fed by the Mississippi River water, in the spring and early summer there is always an influx of Entomostraca, affording for the time ample food supply, but that it is quickly and considerably reduced by the young fishes in the ponds. He therefore recommended some accessory ponds for the breeding of Crustacea. In such ponds all the conditions and requirements having been considered, suitable water plants should be placed, then the initial stock of crustaceans secured. In some localities it is doubtless possible to obtain the plants and crustaceans at the same time from the same source. It has been seen that some forms of crustaceans are adapted to quiet and warm waters, others to cold ponds or the cold depths of lakes and to cold spring brooks, while still others seem capable of existing within a wide range of conditions. On the other hand, some waters may lack some essential element to support crustaceans at all.

These are a few of the points which must be considered, whether it is proposed to raise crustaceans for hatchery food supply or for stocking natural waters. It goes without saying that the most common and most widely distributed species are the forms most easily transported and adapted to the widest range of conditions and uses.

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[7] Unpublished manuscript, 1918.

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PRINCIPLES INVOLVED IN THE PRESERVATION OF FISH BY SALT.[1]

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INTRODUCTION.

The art of preserving fish by means of salt is of great antiquity. It was practiced by the Phoenicians and Greeks and was brought to a high degree of perfection by the Romans. Mixed with spices, salt was used for the preservation of food on the shores of the Mediterranean and the outlying country in the time of Christ, reference being made in the Sermon on the Mount to a salt which has lost its savor, meaning a salt in which the spices have lost their aroma by evaporation. In the centuries following the art continued, both in the Occident and the Orient, to play an important part in world economy. Shakespeare put in the mouth of his most wonderful character, Falstaff, the words: "If I be not ashamed of my soldiers, I am a soused gurnet"[2]—a pickled gurnard, the gurnard being held in such light esteem that it was a term of contempt. Whether "sousing" or pickling made the fish doubly contemptible had better be left to the philologists to determine. Less than 25 years after Shakespeare wrote that play the Plymouth Colony landed in America and brought with

[1] Appendix II to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. 919.
[2] King Henry IV, pt. 1, Act IV, Scene II.

them the arts of sousing and pickling fish. The descendants of the Pilgrims are still pickling fish around Cape Cod and particularly at Gloucester.

To a great many people it may seem that science has contributed little or nothing to the improvement of methods of preserving fish by salt. Perhaps this view is shared by a considerable number of people who are engaged in the business of salting fish. To them it may appear that salting fish is just salting fish, and "that's all there is to it." It may be admitted readily that science has not so pervaded and dominated the fish-pickling industry as it has other ancient arts, but it has contributed something and is capable of contributing a great deal more, and here lies the purpose of this paper. That purpose is to present the rationale of salting and pickling fish, so that the reasons for the various steps and modifications will be readily understood and appreciated, to the end that the art may be practiced more intelligently and successfully. It is a further purpose of this paper, by showing what the few attempts made by science have done for the art, to convince and persuade those on whom the industry depends for its existence and progress that science can be expected to do a great deal more than it ever has done if it is energetically studied and applied.

HOW SALT PRESERVES.

Salt preserves by extracting water. Spoiling is a series of chemical activities for which water is necessary; remove the water and spoiling is arrested. The removal of water by means of salt is in some senses a truer dehydration than actual drying in air, for changes of an undesirable sort take place in air drying that are never corrected, while salting may be done in such a way that few changes other than removal of water are brought about. The statement that salt preserves by extracting water is to be taken strictly and literally, for salt has no peculiar preserving or antiseptic quality, as many people seem to think. Things live, die, and putrefy in the sea, which is one-tenth saturated with salt. But by sufficient concentration salt, an otherwise almost inert, harmless substance, becomes a powerful preservative, merely because, if concentrated sufficiently, it extracts water.

The process of transferring water from one place to another, as from the inside of a fish to the outside, under the influence of concentrated solutions, is known to physicists and chemists as osmosis. This principle of osmosis is of almost universal application in nature and is used by men in the arts, but a good understanding of it is not common. By osmosis our food is taken from the intestines to the blood without any communicating opening. By osmosis oxygen is taken from the air into the blood without any leakage of blood. By the same principle the kidney tubules remove undesirable substances from the body while holding back all desirable substances. By osmosis the roots of plants select the necessary minerals from the soil. A weak sugar solution will readily ferment, but if made concentrated it destroys yeast and bacteria by osmosis and is therefore an excellent preservative of fruits. Salt is also a preservative by virtue of its concentration. Any other neutral min-

eral substance equally soluble would preserve in the same way that salt does, but salt happens to be the only one that the human palate and stomach will tolerate.

HOW SALT EXTRACTS WATER.

At the risk of appearing verbose the writer undertakes to elucidate the principles that govern osmosis, because osmosis is nearly the whole principle of salting fish. Without a knowledge of osmosis people may salt fish successfully by rule, but without such a knowledge it is quite impossible to understand the process.

If a thin animal skin or membrane separates two liquids and if the liquids are alike and of the same concentration, nothing happens. But if they are unlike and of different concentration, one or the other or both of the liquids will pass through the skin to the other side. This passage through the skin or membrane is called osmosis. Just what components pass through the membrane, in what direction, and how much depend on many circumstances. For the purposes of salting fish water is always the liquid, plus whatever is dissolved in the water. The dividing membrane is the skin of the fish and the membranous inclosures of the microscopic cells of which the substance of the fish is composed. We thus have water and salt outside, cell membrane between, and fish juice, or protoplasm, inside, and we desire to know what will happen and how we can influence the process to suit our needs. The quantity and direction of flow through the skin or cell membrane will depend on (1) the nature of the dividing membrane, and (2) the nature and quantity of the substances dissolved in the water on each side.

The nature of the dividing membrane will be considered first. Almost any substance can be made into a thin film or membrane. Such things as glass, tin-foil, and mica may be exceedingly thin, but are totally impermeable and therefore uninteresting in the present connection. But other membranes or films, such as parchment paper, gelatin films, animal bladders, and goldbeater's skins are permeable to a greater or smaller degree. Suppose pure water were on one side of a membrane and water containing dissolved salt on the other. If the membrane is perfectly permeable to all constituents, water will pass through to the salt solution and salt will pass through to the water, and these movements will continue until the two sides are alike and then stop. It is always the tendency for the two liquids to come to equilibrium, and they would do so if the membrane were perfectly permeable. Nearly all membranes, however, permit a freer flow of the solvent, in this case water, than they do of the solute (that which is dissolved), in this case salt.

If the membrane permits the water to flow but absolutely prevents passage of a dissolved substance, the membrane is said to be semipermeable. In the example taken above, of pure water on one side and salt solution on the other, if the membrane were semipermeable then the water would pass through to the salt solution, but the salt could not get through to the water. The level of the pure water would fall and that of the salt would rise. The difference in liquid level would exert a pressure called osmotic pressure. Ideally semipermeable membranes are not realized in nature, though some of the

membranes in plants and animals approach ideal semipermeability while they are living. Ideal semipermeability with respect to particular dissolved substances has been achieved and is found in living organisms.

It is to be remembered that in case of semipermeable membranes the solvent will flow from the less concentrated to the more concentrated side of the membrane, so that if we wish to extract water we need only to make the outside more concentrated than the inside. If we wish to add water, we make the outside less concentrated than the inside; that is, we use pure water outside, as has sometimes been done unfairly to swell oysters and make them appear "fat."

It is also to be remembered that the degree of permeability of membranes does not necessarily remain unalterable. The permeability of the membrane can very readily be changed, as will be seen later. There is reason for believing, for example, that the permeability of fish to salt increases after death—for stale fish strike through more quickly than fresh fish—and that permeability increases at temperatures near the freezing point of water.

The tissues of fish consist mostly of cells. Each cell is a bag of semiliquid, like the white of egg. The surface of every cell either is or acts like a semipermeable membrane. If we surround the cell with water, the inside will be more concentrated than the outside and water will go in. If we surround the cell with strong salt solution, water will pass out to the salt. Some salt will also pass into the cell, which fact shows that the cell wall is not ideally semipermeable.

But what of the protein within the cell? Why does it not come out while the salt is going in? In order to answer these questions it is necessary to pass from a consideration of the nature of the membrane in osmosis to a consideration of the nature of the dissolved substance.

By a great many experiments it has been found that some dissolved substances never pass through membranes under any circumstances, while others will pass through some membranes. It is found that those which never pass through are also those which on drying out do not crystallize but shrink to a tough mass. They are called colloids. Examples of them are glue, albumen, gelatin, and soap. The smallest possible particle of these substances is comparatively large, too large, we may imagine, to go through the texture of the membrane. They are not only large of molecule but complex in structure. The bulk of animal bodies consists of colloids called proteins, dissolved in water. The other class of substances, those that may pass through membranes and which on drying out crystallize in regular geometrical shapes, are the crystalloids. Examples of this class are salt, sugar, and like substances. It is not to be supposed, however, that all crystalloids will pass with equal facility through any given membrane. Nearly all membranes are in some measure selective of particular crystalloids. The ideal semipermeable membrane permits none to pass, but as membranes degenerate from ideal semipermeability to complete permeability they permit more and more of these dissolved things to pass through.

The phenomena of osmosis having been briefly reviewed, one may readily perceive the importance of applying the principles to the salting of fish. Salt is brought in contact with the exterior of the

cell. It dissolves in some of the moisture, forming a saturated solution. This solution is separated from the contents of the cell by a cell membrane which is more or less semipermeable. Water passes out of the cell to the salt and the processes of decay are stopped because of insufficiency of water. The membrane, not being absolutely semipermeable, permits some salt to enter and the fish remains salty. The contents left in the cell are proteins or the valuable food elements of the fish which, being colloids, are not permitted by the cell membrane to pass out. Thus water is extracted, salt enters, and the fish is preserved.

When the time comes to eat the fish the process is exactly reversed. The fish is bathed in pure water. The cell contents are more concentrated than the exterior, so water passes in. The cell membrane is to some extent semipermeable, so the protein does not escape, but the salt does. This exchange is carried to a point where the meat is again plump and a sufficient quantity of salt has been removed.

Thus by exposing the meat of fish to salt we have removed the water and caused some salt to enter the meat and have stored the fish. We have then by exposing the fish to water put water back in the cells and taken out the excess salt. The actual food material of the fish—the cell protein—is still where it was, for practical purposes unchanged. If every step has been scientifically correct we have at the end very nearly the fresh fish we had to start with. But there is the rub. At every turn it is possible to depart from the scientifically correct. The principles of osmosis here very briefly stated are the fundamentals of the art of salting fish. In all that follows there will be frequent occasion to refer to osmosis.

FACTORS AFFECTING PERMEABILITY OF FISH.

The preservation of fish by salt is practiced extensively in the cooler parts of the United States, but very little has been done south of Chesapeake Bay. The reason fish have not been salted in the warmer parts of the country is that the process has not been satisfactory. Repeated efforts to salt alewives on the St. Johns River in Florida previous to 1920 uniformly resulted in failure. In 1918 research on this problem was undertaken under the immediate direction of the writer. The results of a part of this program were published.[3]

The hypotheses which guided this work were somewhat as follows: During the course of "striking through" the fish two things are happening—(1) the flesh is breaking down by autolysis (a process to be explained later) and (2) the salt is penetrating the flesh. Salt arrests autolysis when it arrives, but considerable damage may be done before the salt has reached the innermost parts of the fish. Now, these two processes—salt penetration and autolysis—are running a race, so to say. If the salt penetrates to the innermost parts before autolysis has destroyed them, the salt wins the race and the fish is saved. If before the salt can get to the innermost parts they have been decomposed by autolysis to an intolerable degree, then autolysis wins and the fish spoils. High temperatures accelerate both processes, but while accurate measurements have not been made we know

[3] Tressler, D. K.: Some Considerations Concerning the Salting of Fish. Appendix IV. Report of the U. S. Commissioner of Fisheries for 1919, 55 pp. B. F. Doc. No. 884. Washington, 1920.

by practical experience and by experiment that at a sufficiently elevated temperature the fish will invariably spoil if blood be present. Now, to make certain that the race mentioned shall always be won by the salt, we may do one of two things, namely, retard the rate of decomposition or accelerate the penetration of salt. Working at a lower temperature is the only practicable means of retarding decomposition, but since we desire a method suitable for warm climates it is necessary to accelerate penetration of salt. How can the salt be caused to penetrate fish more rapidly?

The physiologists have shown that in living animals compounds of calcium, barium, and magnesium have a marked effect in retarding or arresting penetration of membranes. By examination of numerous analyses of commercial brands of salt it was found that the salts of calcium and magnesium are those nearly always present as impurities. A few of these analyses are given herewith:

ANALYSIS OF VARIOUS SALTS FOR CURING FISH.[1]

Substances present.	Turks Island salt.	Trapani, Italian salt.	Iviza, Spanish salt.	Diamond Flake, domestic salt.	Leslie Velvet Grain, California salt.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sodium chloride	96.52	95.82	98.05	99.78	99.96
Calcium chloride		.32	.49		
Calcium sulphate	1.53			.37	.067
Magnesium chloride	1.20	1.19		.00	.00
Magnesium sulphate	.80	1.75	.80	.00	.010
Sand, etc	.13	.15	.06	.00	.022

[1] These figures represent analysis of single samples of each brand taken in the market and are not averages of numerous samples. Not only is some variation in manufacture unavoidable, but the chemical determination of such small quantities of impurities is subject to small errors. Therefore it should not be expected that any purchased lot of salt would conform exactly to the composition shown here. The figures represent in a general way the degree of purity that can be expected.

By appropriate methods of measuring the rate of penetration of salt into fish it was found that if absolutely pure salt is used a very rapid penetration is obtained, but that even small additions (from ½ to 5 per cent) of these salts of calcium and magnesium cause a very pronounced retardation of penetration. For example, by appropriate methods of analysis it was found that pure salt penetrated as deeply in less than five and one-half days as did salt containing 1 per cent calcium chloride in nearly seven days. Similarly, a salt containing 4.7 per cent magnesium chloride penetrated no farther in five days than pure salt did in three. In order to bring about a much more rapid penetration of the tissues then, we have but to obtain a salt free from these impurities. The time gained by the use of pure salt enables fish to be salted at a much higher temperature and yet not spoil. Fish were salted in an incubator room in Washington at a temperature of 90° F. at first, rising to 100° F.—the hottest summer weather. No unpleasant odor developed, and the fish upon being cooked and eaten were pronounced excellent.

There was a further and somewhat unexpected difference between the effects of pure and impure salts. The flesh of the fish salted by impure salt is white, opaque, or chalky in appearance and much harder or firmer in consistency; that of fish salted with pure salt is translucent and somewhat yellowish and much softer. While the former white, firm fish is the customary quality demanded in com-

merce, there are strong reasons for believing the softer and yellowish fish produced in pure salt to be superior. There is reason for believing that the whitening of the fish in impure salt is explained by the fact that the calcium coagulates the protein, just as heat by coagulating egg white causes it to be white and firm. But where there is no calcium in the salt the protein retains its natural translucency and yellowish color. The calcium in impure salt is retained by the fish, a matter that will be discussed later under the subdivision on flavor of salted fish.

While no investigations appear to have been made on the influence of temperature on the permeability of fish flesh, investigations have been made on a great variety of other living things, so that it is probably safe to generalize cautiously regarding such influences on fish. Osmotic pressure varies, approximately, as absolute temperature.[4] That is, if we double absolute temperature osmotic pressure is doubled, other factors being held constant. The range from 32 to 100° F. within which fish salting is usually done is, on the absolute scale, rather narrow (491.4 to 559.4° A.), so the maximum variation due to this cause would be about 14 per cent. It is, however, a common experience in pickling fish that the warmer the temperature the more rapid the striking through, a difference too great to be accounted for by temperature variations of osmotic pressure. The cell membrane itself must change. Whether any more free permeability caused by warm temperature is permanent after the fish is chilled again is not known, but the question would be well worth investigating. Cold, when in the neighborhood of freezing, also promotes permeability, as has been proved by various experiments. It is quite possible that fish chilled to a point near freezing (as in the mild curing of salmon) would strike through much more quickly than fish at the customary warmer temperatures. This matter also should be investigated.

Stale fish—that is, fish whose cell membranes have "died"—are more permeable than fresh fish. Some fish were held in the laboratory all day at a temperature of about 75° F. and toward night were salted in pure salt and put in an incubator at 100° F. By the next day they were struck through. The combination of stale fish, high temperature, and pure salt brought about extraordinarily rapid penetration.

At this point mention should be made of another effect of salt upon the protein constituents of fish. Strong solutions of salt precipitate certain protein substances, different substances falling out successively from a mixture of dissolved proteins as the concentration of salt is increased. The nature of the proteins is not altered by this precipitation, for upon replacement of the salt solution with fresh water the proteins redissolve and appear to be restored to their original condition. Salt thus causes a temporary precipitation or fixation of proteins in fish, to a certain extent hardening the tissues and reducing the likelihood of changing. Not only does quite pure salt penetrate the fish more rapidly, but when the time comes to cook the fish it is found to soak out more rapidly also. Practical experiments in the experimental kitchen of the Bureau of

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[4] Absolute temperature is based on absolute zero, the point of no heat, or absolute cold, which is −273° C. or −459.4° F. If we use degrees the same size as Fahrenheit's degrees, then 0° F. is 459.4 absolute; 50° F. is 459.4 + 50=509.4 absolute, etc.

Fisheries indicate that fish preserved in very pure salt soak out in from a third to a half the time required by fish preserved in crude salt.

What is the practical lesson of this work? It shows that by the judicious selection of salt, not on the basis of its cheapness but on the basis of composition, one can produce a salt fish of almost any desired quality. If salting is to be done in very warm weather it will be necessary to use the purest grade of salt to secure very rapid penetration. In this way a soft, yellowish fish of excellent quality is obtained. Where weather is cool enough to permit, a salt containing more calcium and magnesium may be used, in which case a whiter and firmer fish will be produced.

Can these very pure salts be obtained commercially? Several brands of salt of the highest degree of purity are available both on the east and west coasts and at a cost not much above the price of cruder salt. In many cases the single item of fish saved that might otherwise spoil will repay the extra cost of pure salt, to say nothing of the improvement in quality of the salt fish.

FLAVORS OF SALT FISH.

The calcium and magnesium are taken up by the protein in the cells and held, not coming out when the fish is soaked. Now, these impurities, particularly calcium, have an acrid taste and greatly accentuate the "saltiness" of salt. Pure salt is not so "salty" to the taste as crude salt. If the calcium is held by the tissues at the time of soaking out while the salt is removed, then after soaking there is a much greater amount of calcium present in proportion to the amount of sodium than there was in the original salt and a correspondingly more acrid "salty" taste. It is therefore necessary to soak out fish much longer or until they are "flat" if they have been cured with crude salt, while with pure salt they may be soaked out until they suit the taste, after which they retain their original flavor.

Certain improvements in the flavor of fish have been noted after they have been salted by improved methods. The fish variously known as mud shad or gizzard shad (*Dorosoma cepedianum*) is plentiful in certain parts of the country but is held in very low esteem because of its muddy, unpleasant flavor. After being washed free from blood and salted in pure salt this unpleasant flavor disappeared and the fish compared favorably with fish commonly more esteemed. The muddy taste of the carp and other fish from muddy ponds and streams is believed by some to be caused by species of Oscillatoria, a blue-green alga growing in the slime of the fish; by others it is believed to be humic acid derived from the mud. Perhaps the two views could be entirely reconciled, but the actual chemical compound or compounds responsible for the unpleasant flavor seems to be removed by the brine.

It is not difficult to understand how the alteration of taste may be brought about by salting. The main bulk of the fish, pure protein and pure fat, is believed to be tasteless and odorless. The substances which give rise to taste are free fatty acids (decomposition products from fats), amino acids (decomposition products of proteins), highly odoriferous *methylamines*, and various waste materials classed by the chemist as *purines*. The absolute quantities and also the relative proportions of these materials vary from species to species of fish,

and they even change in the same individual fish as staleness develops. Now, most of these odoriferous substances are soluble in water or brine, and after the salting process would be found in the brine. They are not replaced when the fish is soaked out. It might therefore be anticipated, as has actually been found, that the fresh fish, disagreeable because of the presence of strong substances, are rendered sweet by the removal thereof in the salting process.

If this lead were followed in detail, it is quite possible that salting would turn out to be the best method of utilizing fishes that are of a rather poor edible quality when in the fresh condition. This aspect of the matter deserves particular attention of the canners. Many species of fish of great abundance might in time be profitably packed if the flavor were inviting. With highly improved technique in salting, the undesirable flavors might be removed by curing and soaking out before canning. This process would be unthinkable on the basis of the customary salting methods where there is in the end an excessive saltiness or flatness of flavor, but the mild, sweet fish prepared by improved technique and pure salt is a much more promising possibility for canning.

DRY SALTING AND BRINE SALTING COMPARED.

The next question taken up in the investigations referred to was that of the relative merits of the application of the salt to fish in the dry state and as a concentrated brine. In the Chesapeake Bay region the herring are usually pickled in brine. By a strict comparison of the two methods it was found that there is developed a smaller quantity of the products of decomposition—the amino acids—when the salt is applied dry. Not only this, but it was also found that salt applied in the dry condition penetrates the fish more rapidly.

Among the products of protein decomposition are amino acids. A determination of amino acid nitrogen was taken as a measure of decomposition—the more of the amino acid nitrogen present the greater the amount of decomposition. This being true, the following table, summarized from Tressler's results, will show the superiority of dry salt over strong brine for preserving fish.

AMOUNTS OF AMINO ACID NITROGEN FORMED PER KILOGRAM OF FISH AT DIFFERENT TEMPERATURES.

Method of salting.	Temperature.	Amount of amino acid nitrogen per kilogram of fish after—					Condition at end of salting period.
		19 hours.	67 hours.	5 days.	7 days.	9 days.	
	° *F.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	
Dry salted	63	0.078	0.083	0.085	0.085	0.119	Good.
Brine salted	63	.089	.129	.135	.183	.234	Do.
Dry salted	70	.084	.086	.098	.097	.126	Do.
Brine salted	70	.100	.165	.158	.190	.292	Do.
Dry salted	75.5	.077	.092	.099	.104	.134	Fair.
Brine salted	75.5	.102	.186	.179	.228	.316	Do.
Dry salted	80	.074	.086	.119	.141	.158	Do.
Brine salted	80	.086	.189	.210	.300	.383	Spoiled.
Dry salted	87	.076	.089	.159	.195	.208	Do.
Brine salted	87	.097	.244	.266	.377	.510	Do.
Dry salted	93	.065	.105	.151	.193	.236	Do.
Brine salted	93	.080	.238	.320	.465	.666	Do.

It is seen that the brine-salted fish consistently undergo a greater decomposition than those salted with dry salt, as shown by the abundance of decomposition products, amino acids. The average excess of amino acid nitrogen in the six lots pickled in brine over the six lots in dry salt is 51 per cent, a very material difference. It will be noticed in the last column of the table that spoiling of fish pickled in brine takes place at a lower temperature than it does in dry salt. Fish were satisfactorily salted in dry salt at 80° F., but at this temperature fish pickled in brine spoiled.

To complete the evidence in favor of using dry salt, the following table from the same paper shows the rate of penetration of salt into squeteague when applied dry in comparison with brine:

PENETRATION OF SALT.

Method of salting.	Section of fish.	Percentage chlorine in dry sample after—			
		1 day.	4 days.	7 days.	10 days.
Dry salted	Outer layer, from surface to a depth of ½ centimeter.	9.8	16.2	19.6	19.5
Do	Inner layer, from ½ to 1 centimeter below surface.	2.6	11.0	16.0	18.7
Brine salted	Outer layer, as above	8.4	15.3	17.3	17.8
Do	Inner layer, as above	1.8	8.3	12.2	15.7

What is the reason for the superiority of dry salt over strong brine or pickle, especially since the dry salt very shortly forms its own pickle? In answer to this question it is necessary to refer to the principles of osmosis. It was shown that the flow of water is from the less concentrated to the more concentrated. The relative concentrations govern the direction of flow and also the rate or quantity of flow. Salt is going into the fish and water coming out. If brine is used, it is losing some of its salt which penetrates the fish and is being diluted with water which is coming out. This process rapidly brings the contents of the cells into equilibrium with the brine; that is, with the film of brine immediately in contact with the fish. Stirring as usually done may cause a momentary increase of penetration by removing the film of dilute brine adjacent to the fish, but we may imagine that a new dilute film forms again very rapidly. If instead of brine dry salt is placed in contact with the fish very material differences are at once apparent. Part of the salt dissolving in the free moisture forms strong brine, which begins its extraction of water from the fish. The water coming from the fish is not able to dilute the adjacent brine, because some of the excess of dry salt present immediately dissolves, and thus assures saturated brine at all times. It should also be obvious that since the very purpose of using salt on fish is to extract water the addition of water at the beginning simply supplies just so much water to the salt and satisfies the affinity of salt for water to that extent. The water should come from the fish and not elsewhere.

To put into words the conclusions from this section of the paper, when salt is applied dry to the fish there is a more rapid penetration of salt, less decomposition of fish, and it is possible to preserve fish

at a higher temperature. The superiority of dry salt over brine resides in the fact that the brine in contact with the fish is not permitted to be diluted if salt is present in crystalline condition.

LOSS BY FISH OF NUTRIENTS IN BRINE.

The liquid that comes from fish during the salting process is not pure water, as every fisherman knows, but contains a quantity of material derived from the fish. Most of the nitrogenous matter found in brine represents just so much good food gone to waste and just so many pounds of fish that might have fetched a good price gone overboard. The quantity of protein that escapes into the brine is highly variable, for reasons that will appear later. That some idea may be had of the magnitude of the loss of fish substance in brine the following figures are given. These figures were obtained in the course of investigation on the recovery of valuable materials from old brine:

Loss by Fish of Nutrient Materials in Brine.

Brine.	Grams dry protein per liter of brine.	Avoirdupois ounces per gallon.
Rockfish brine from Alaska	29.30	3.9
Herring brine from Gloucester	34.80	9.8
Cod brine from Gloucester	73.30	4.6

Since all the nitrogen in the brine was calculated as protein, these figures are undoubtedly too high; but the bulk of the nitrogen is certainly of protein origin, so the figures may be taken to illustrate the point made. If we assume fresh fish to be 75 per cent water and 25 per cent dry protein and express the results in customary units, the figures show the equivalent amount of food-fish flesh dissolved in brine to be 15.6, 39.2, and 18.4 ounces, respectively, or from 1 to $2\frac{1}{2}$ pounds to the gallon of brine. Bitting[5] calculated the losses in the curing of codfish as follows: Loss of weight in dressing, 40 per cent; loss in salting, 40 per cent of what remained after dressing; drying on flakes, 9 per cent of the salted fish. The 40 per cent of the dressed fish contains besides water much protein or valuable nitrogenous food. It would certainly seem to be worth our while to examine into the causes of this loss and to prevent or salvage it if possible.

How does this protein get out of the fish? It was said above that protein is a colloid and that colloids do not diffuse through membranes. A small amount must come from the blood and from the cut surface on the fish, but most of it will probably be found to come from the interior cells by a process not yet investigated. We do know something directly about autolysis, however, the great enemy of the fish dealer, which liquefies the contents of fish flesh, and we have every reason to believe that if autolysis were stopped the losses of protein into brine would be reduced to a minimum. What is autolysis and how does it do its damage?

[5] Bitting, A. W.: Preparation of Cod and Other Salt Fish for Market, U. S. Department of Agriculture, Bureau of Chemistry, Bulletin No. 133, 63 p. Washington, 1911.

Protein, the colloid, can not pass through an osmotic membrane, but proteins can be decomposed into simpler substances which readily dissolve and pass through. The agency which breaks down protein into these simpler substances is called an enzyme, and protein must always be so liquefied or digested by enzymes before it can be absorbed through membranes; hence the necessity of digestion in the stomach of animals preparatory to absorption of food through the intestines. Now, animals, including fish, require a certain amount of new protein to support the body activities, which, failing, the animal would immediately perish. But the hazards in the existence of any animal often make it obligatory to do without food for a shorter or longer period. If the stomach became empty because of temporary shortage of food or an injured mouth, the animal would die unless special provision were made to supply protein from some other source. But nature has provided a means whereby the proteins in the less important parts of the body can be used for the time being to support the activities of the absolutely necessary vital parts. The stored protein is within cells and could not possibly be carried by the blood stream to the point of need unless it could get out. So there is in each cell stored along with the protein some enzyme ready in case of threatened starvation to break the protein down into simpler substances which penetrate outward into the blood for transportation to the point of need. Fish may thus live for a time at the expense of their own bodies.

These enzymes, present in every part of the fish, while almost an absolute necessity to the living fish, become the greatest enemy of the dead fish, for they soften and liquefy the cell contents, cause unpleasant tastes and odors, and permit the contents to escape from the cell into brine. The proteins could not escape as long as they were proteins, but when they are broken down by autolysis into simpler substances the latter rapidly diffuse into the brine and are lost. This at least is the hypothesis, supported by some facts.

What factors promote autolysis and what factors oppose it? Warm temperatures promote it directly. A temperature sufficiently high to destroy the enzyme stops it. Low temperatures retard it directly.

If cells are ruptured, as they often are by rough handling of the fish, autolysis rapidly decomposes the protein, and for this reason every bruise received by the fish during capture and subsequent handling results in the loss of so much protein during salting. A bruise on a fish has about the same effect as does a bruise on an apple, promoting rapid decomposition. Perhaps if the bruised fish turned brown, as the bruised apple does, the fisherman and packer would be more careful in the handling of their fish.

Factors that increase permeability of membranes seem to promote autolysis. Low temperatures seem to increase the permeability of the cells, so that fish that have been chilled decompose more rapidly on being warmed than fish that have never been chilled, though as long as the fish remain on ice the low temperature may prevent the enzymes from doing their work. It is as if increased permeability increases the escape of the enzymes, and that once escaped they play havoc if temperature conditions are allowed to become favorable. The optimum temperature for autolytic activity is about human body

temperature, 98° F. The autolytic enzymes act under a slightly acid condition. In neutral or alkaline medium they act very little, if at all. It has been noticed by various investigators that autolysis does not begin until two to four hours after death. During rigor mortis there is a decided development of acid that may very materially promote autolysis. It may therefore be that salting fish immediately after capture would strike through the fish before autolysis gains any headway. It may be possible, also, to take advantage of the removal of soluble products by brine in the salvaging of fish on the point of spoiling. Fish that have been held a long time are soft and of a disagreeable odor, because autolysis and possibly some bacteria have decomposed the tissues to some extent.

One might reasonably expect research to show that if rapid penetration is secured by means of pure salt the amino acids and other sour or disagreeable substances in stale fish resulting from autolysis would be removed by changing brine a few times, leaving the fish in a condition quite wholesome and fit for food. It is, of course, not intended here to encourage the practice of holding fish until they are bad and then salting them, but it is recognized that it is in the public interest neither to destroy food that can be used nor to market fish unfit for food, and it is recognized as legitimate and desirable to develop a means of saving fish whenever they have, through the unavoidable exigencies of the fishing business, come near to spoiling.

It would not be profitable to present this complicated subject any further here. Enough has been said to show that the loss in salting fish by solution of protein in brine is very great. Some discussion has been presented which will serve to show that losses of this kind are preventable, to point out the probable direction in which the remedy for this great loss will be found, and also, we hope, to assist in convincing the skeptics that scientific work on this aspect of the salting process would be worth while. It is of the greatest importance that research work be undertaken for the purpose of discovering the conditions under which the cell proteins are digested and pass out and for ascertaining the conditions under which these processes may be arrested. Specifically, such questions as follow should be answered: Once the permeability of cells has been increased by abnormally high or low temperature, does this increased permeability persist after a normal temperature has been restored? When autolysis is set in action by a bruise, do autolytic enzymes affect only the part bruised or do they escape and attack the uninjured cells, destroying them also? To what extent does the acid of rigor mortis accelerate autolysis, and can this acceleration be prevented by early application of salt? To what extent is loss of soluble material in brine due to rough handling and to what extent to other factors? Can advantage safely be taken of the removal of products of protein decomposition by brine to salvage fish that are on the point of spoiling?

INFLUENCE OF METHOD OF CLEANING FISH ON SALTING.

In the various processes of salting or pickling fish the fish receive no preliminary treatment, or they may be gibbed, beheaded, split through belly, split through back, or cleaned perfectly by being cut

open, scraped, and washed before the salt is applied. By what criteria can we judge the merits of these various methods? The best way to answer this question is: Other conditions being held constant, which method or methods of cleaning result in least decomposition during the salting process?

A series of trials was made by cleaning the fish by the various methods and salting them by the same process and determining the amounts of amino acid nitrogen developed. Two sets complete were tried, one consisting of one sample each cleaned by the various methods and held at a temperature of 79° F. during the salting process; another set similar to the preceding but held at 88° F. during the salting process. Both temperatures are high for salting fish, and the test is correspondingly severe. The results are shown in the following table, which is abbreviated from the paper by Tressler:

DEVELOPMENT OF AMINO ACID NITROGEN IN FISH CLEANED IN VARIOUS WAYS.

[Fish salted four hours after capture, with Diamond Flake salt containing 99.78 per cent sodium chloride; salting period, nine days.]

Method of cleaning.	Average temperature of salting.	Amino acid nitrogen formed during salting period per kilo of fresh fish.	Condition of fish at end of period.
	°F.	*Grams.*	
No cleaning, salted round	79	0.77	Badly spoiled, bloated.
Pipped	79	.63	Spoiled.
Head cut off, abdominal cavity split open, viscera, except milt and roe, removed.	79	.68	Do.
Cleaned perfectly, milt and roe removed, kidney and membranes scraped, and all blood washed out.	79	.37	Excellent condition.
No cleaning, salted round	88	1.12	Badly spoiled, bloated.
Pipped	88	.76	Badly spoiled.
Head cut off, abdominal cavity split open, viscera, except milt and roe, removed.	88	.82	Do.
Cleaned perfectly, milt and roe removed, kidney and membranes scraped, and all blood washed out.	88	.47	Excellent condition.

Since amino acid nitrogen indicates decomposition, the conclusions from this table are entirely obvious. Only those fish were successfully salted at temperatures of 79 and 88° F. which had been thoroughly cleaned and from which all blood had been removed. While these high temperatures were chosen for the test because severe tests bring out differences in a more striking way, the differences will still exist even at lower temperatures and manifest themselves in the poorer or better quality of product. Now, it may be either the blood or flesh, or both, in which the decomposition takes place. Since the perfectly clean fish decompose only slightly, it may be that only the blood decomposed in such cases as those given in the table, and that the decomposed blood pervading the otherwise sound tissue gave the appearance and odor of decomposition to the whole fish. On the other hand, it is possible that the enzymes in the blood when present operate to decompose not only the blood proteins but the tissue proteins also. However, this may be, the indisputable fact remains that if fish are to be salted in very warm weather it is absolutely

obligatory that the blood be removed. The blood can not be removed by mere eviscerating and rinsing in water. The kidney, a very bloody organ inclosed by a membrane against the backbone, must be scraped out before the fish is washed. If fish is cleaned in this manner and salt of a very pure quality applied in the dry condition, it is astonishing not only what severe temperatures it will stand, but also how excellent it is when cooked.

IMPROVED METHOD OF SALTING FISH ESPECIALLY FOR WARM WEATHER.

Several factors have now been shown to have a marked influence on the quality of fish pickled in salt, namely, care in handling before salting to prevent bruises, use of salt free from calcium and magnesium (less than 1 per cent total impurity), packing in dry salt, and thorough cleaning and removal of kidney and blood. By combining all these factors into one method highly satisfactory results under the most adverse conditions have been obtained.

A trial of the method was made in the herring season of 1920 (March, April, and May) on the St. Johns River, Fla. This region was selected because it offered a combination of the conditions sought. The climate is excessively warm, and there is an abundance of fish (alewives) adapted to preservation by pickling in a region where an industry might well be built up and where repeated efforts to salt fish in the past had failed. Accordingly, the interest of local fishermen and dealers was enlisted to cooperate in the undertaking, and an experienced fish packer from the Chesapeake Bay region was sent to Florida, after he had been thoroughly instructed in the technology of the process, to try salting by the proposed method on a small commercial scale.

The details as conveyed to the fishermen for handling the fish were: (1) Avoid (*a*) bruising the fish in removal from gill nets, (*b*) walking on, and (*c*) piling deep in boats; (2) salt as soon as possible; (3) wash and scale in cold water; (4) behead and eviscerate and (*a*) scrape out kidney or (*b*) split nearly through to the back and lay open; (5) wash in weak brine to remove all traces of blood; (6) rub with fine salt of a high degree of purity and pack backs down in a barrel, leaving fish lightly covered to form their own brine; (7) after they have been struck through pack down and add other fish of the same lot to fill barrel; and (8), in conclusion, (*a*) head up barrel and pour saturated brine into bunghole to cover fish for storage, or (*b*), if to be sold for consumption at once, take out of the brine and rub in fine dry salt, then pack in sugar barrels or other light containers and ship immediately.

The results fully justified expectations in every way. The fish were preserved successfully, and none that had been handled in the prescribed way spoiled. In eating qualities they were pronounced as good as or better than the best commercial salt herring from the Chesapeake Bay region. In order to test the absolute necessity of the prescribed methods, other small batches were put up in different ways—by using cheaper salt, leaving roes in, and other such modifications. These trials were failures without exception. About 80,000 fish were packed by the prescribed method and marketed the first year.

The successes and failures under these extremely adverse conditions tell us much about what could be expected under more favorable conditions. What succeeds under severe conditions will be a finer product under more favorable conditions, and what spoils under severe conditions will be an inferior product under conditions in which it does not actually spoil. It should be noted that the product prepared by this method is mild and sweet, approaching very closely fresh fish in eating qualities, if it has been properly soaked out.

SCOTCH-CURED HERRING.

The discussion in this paper so far presupposes the desirability of preserving as far as possible the flavor and eating qualities of fresh fish. The Scotch cure does not involve this supposition but aims directly at giving the cured fish a new and distinct flavor from partly decomposed or fermented blood, the purpose being the same as that governing the flavoring of cheese by ripening. The blood is not removed, the fish rather being allowed to cure in its own blood pickle, a distinctive flavor thereby being imparted. They are gibbed, rubbed with dry, fine salt and packed, more fish being added to make up for shrinkage, and shipped or stored in the original blood pickle. This method is suitable for cold but not for warm climates. Since, however, Scotch-cured herring come in a special class of fermented products where different motives and processes are concerned, the method will not be further discussed here.

MILD-CURED SALMON.

In the preservation of salmon by salting advantage is taken of the naturally cool temperatures prevailing in the Northwest, so that the extreme of dehydration by salt is not necessary. Even here no chances are taken, for in most instances the casks of mild-cured salmon are held in cold storage at about 38° F. The selection of salt is principally on the basis of fineness, because a fine-ground salt is necessary to stick to the moist fish, only that which sticks to the fish being used dry. It appears that in the mild curing of salmon some of the principles already referred to may be important. It was pointed out that calcium and magnesium salts combine with the fish protein to form a white, hard flesh. In the case of salmon it is desirable to preserve the red color which is contained in the fat, but the precipitation or coagulation of the otherwise transparent protein is in all probability the cause of whitening, which masks the attractive red color of the fat. Also, what was said about the loss of nitrogenous matter as a consequence of bruises applies to the mild curing of salmon.

BEHAVIOR OF FAT DURING SALTING PROCESS.

So far in this paper discussion has been limited to the behavior of the protein or meat constituents of fish. It will be found that fat is also of the greatest importance and requires very careful consideration and study. All fishes have some fat, but the quantity is variable from species to species, between individuals of the same species, and within a single individual from season to season. The distribution of fat is also different in different species of fish. Some fishes, such

as herring, salmon, and alewives, contain fat well distributed throughout the body tissues. In others, such as cod and haddock, the fat is localized in some particular part of the body, as in the species mentioned the oil is contained in the lever, the flesh being almost entirely destitute of oil. For reasons that will be set forth later fat fish must not be exposed to the air because of untoward changes that air causes in the fat; but no harm is done to the protein constituents. Therefore fish which do not contain fat may be dried in air after they are salted.

In practice these differences are well recognized. In the case of cod and haddock, in which the muscle tissue is free from fat, the greater part of free water is extracted in the usual way by salt, later assisted by the pressure of piles or kenches, in which the lower layers are pressed by the weight of the upper layers in the kench, and finally by drying out of doors or in artificial drying tunnels. Fish prepared by this method are packed and shipped in the dry state, with advantages in saving of freight and simpler handling in general. In the case of mackerel and herring and such other fishes as have fat tissues the fish must at all times be carefully excluded from contact with air. If the fish are directly exposed to air for a time, the fish "rust"—that is, the fat becomes reddened and rancid—and the value of the fish for food is very greatly impaired. This rusting, especially of salt mackerel, is of immediate and pressing practical importance, for there is a regular waste of a large percentage of mackerel on our northeastern coast for no other cause than rustiness and rancidity. This aspect of the subject has not been investigated to any great extent, but there is just as much reason to expect valuable results to accrue from work on this problem as have accrued from the work already described.

Fats consist of a combination of glycerin with fatty acids. In the absolutely pure state, which is scarcely attainable, in fact, they would presumably be colorless, odorless, and tasteless. They usually contain a greater or smaller quantity of coloring matter dissolved, and under certain conditions the combination, glycerin-fatty acid, may be broken down, free glycerin and free fatty acid resulting. Free fatty acid has both taste and odor; in fact, our choicest fishes, such as salmon, shad, and mackerel, owe much of their peculiarly palatable flavor to the small amount of free fatty acid present. But many of the free fatty acids of fish oils readily oxidize on exposure to air and light, developing during the process a darker color and an unpleasant odor and taste which we call rancidity. Once fats have become rancid they can never be restored to their original sweetness.

What conditions promote rancidity? First, the fat must be decomposed or "split" into glycerin and free fatty acid. Next it must oxidize. Just as fish contain autolytic enzymes that decompose protein, so they also contain fat-splitting enzymes. These enzymes require moisture and warmth for their activities. Fat that has been removed from the tissue that produced it may be kept under proper condition for a long time, because only a small amount of fat-splitting enzyme goes with the oil, but when the fat is not removed from the original source all the enzyme is present and available to produce

decomposition. So in salt fish the fat is in the presence of moisture and an abundance of enzyme, and the necessary warmth is usually present also, ideal conditions for decomposition. The fat having been split to fatty acid, there are two factors, so far as known—namely, air and light—which promote oxidation.

Some little study has been devoted to the effect of salts, such as sodium chloride and calcium chloride, on the splitting of fats, but not enough is known about the effect of these substances in concentration to be of any assistance. Whether or not bruises have the effect in promoting decomposition of fat that they have in promoting decomposition of protein is not known but would be well worth knowing, and here further investigation is certain to be of value. It is known that much of the fat in living fish is contained within inclosed cells, and that even the fattest fish is not greasy when fresh. But whenever the cells are ruptured by rough handling, decomposition or whatever cause, the oil escapes and is exposed to all the unfavorable influences of enzymes, moisture, air, and light, and the fish becomes greasy; eventually it will become rancid. And, further, oil escaped from the fish, being of a lower specific gravity than brine, at once rises to the top of the barrel and is lost as food.

All sorts of possible preventives of rust are practiced or suggested for practice—such things as impermeable barrels, air-proof covering over the liquid, a reducing substance in the brine to absorb the oxygen, cool, dark storage, and the like. There is, of course, much dissolved oxygen in the juice of the fish and in the brine and also considerable amounts of free oxygen occluded in the cavities of the fish to effect considerable rancidity, even if all outside air is excluded. This dissolved and occluded air can be removed by a vacuum pump, but this has never been tried commercially, so far as the writer is aware. Very little improvement can be expected until the problem has been thoroughly investigated by scientific methods. In the improved technique recommended by the Bureau of Fisheries in Florida complete covering of the salt fish by brine in tight barrels was specified.

REDDENING OF COD AND HADDOCK.

If cod and haddock escape rusting because of lack of fat, they are subject to another enemy perhaps as bad, namely, reddening, by which large quantities of cod and haddock are lost every year. For the past three years work has been conducted by the division of scientific inquiry of the Bureau of Fisheries on the causes of reddening and significant results have been obtained. The cause, in general, has been known for many years to be bacteria, but otherwise little has been known of the origin of these bacteria or of their peculiarities.

Briefly stated, the results of the work cited are as follows: The bacteria that cause reddening are of two distinct kinds—a spirochaete, which in colonies is pale pink, and a bacillus whose colonies are deep red. The two organisms grow in such close harmony that mixed colonies occur which vary in color from pale pink to deep crimson as the proportions of the two organisms present vary. The evidence points to the solor sea salts from the tropical and subtropical seas as the source of the infection. Solar sea salts, both American and foreign, are infected. Mined salts seem to be free from the infection.

Every species of bacteria is acclimated to some particular set of conditions, some of them almost incredible for living things. These red bacteria are accustomed to live and grow either on moist salt or very strong salt solutions. If bacteria are particularly resistant to some condition, as to strong salt in this case, it does not follow that they are likewise resistant to all severe conditions. It is the bacteriologist's business, by studying all the habits and peculiarities of the organism, to discover its weakest point where attack will destroy it. The strongest resistance of these bacteria, that against salt, is also the weakest, for it has been found that water less than 15 per cent saturated destroys them. Thus, the present indications are that the best and simplest remedy for the trouble is clean, fresh water and plenty of it. There is some evidence that may support the view that the usual impurities in salt, calcium and magnesium compounds, are essential to the growth and multiplication of these bacteria. The implication here is, of course, that pure salt itself would be a poor supporter of the bacteria. Of course, it would be futile to try to stop the reddening of cod as long as every shipment of salt brings new infection, and the butts, floors, buildings, and the surroundings at packing plants are heavily infected. Facts already given indicate also that for other reasons salt free from impurity is better. The results of the study of reddened cod only emphasize this advice.

The research on reddening should not, however, end here. We are again dealing with questions of permeability. The bacteria are adjusted to strong salt solutions, that is, the body fluid is of such concentration and their covering membrane is of such partial permeability that when surrounded by strong salt solution they live normally, but when water or weak brine surrounds them these relations are disturbed and they die. Probably water enters the cell in excessive quantity. It is known that the reddening does not attack fat fish. Perhaps the fat acts directly on the membrane, or indirectly by acting on the calcium and magnesium in the salt, to effect the disturbance.

RECOVERY OF BRINE.

Even crude salt now costs considerably more than coal. Yet the fish packers, who are usually very careful to economize in coal, are prodigal in the use of salt. Every hundred pounds of brine that goes overboard contain about 25 pounds of salt, to say nothing of the valuable nitrogenous matter that the brine has extracted from the fish. Considerable work has been done by the writer and his associates on the development of a process to recover salt and other substances of value from old pickle by precipitating the proteinaceous matter with sodium silicate. A trial plant was in use and under observation at an important fish-packing establishment for over a year but was not satisfactory under the circumstances. Brine pure enough for use was recovered, while a substance very rich in nitrogen was yielded as a by-product. This substance in the dry condition is nearly white and friable and contains enough nitrogen to command a handsome price as fertilizer if suitable for that purpose, but it may be more valuable for other uses. The method recovered brine, and for this reason some other method that would pro-

duce dry salt may be better. The experience gained in the work already done indicates that the recovery of valuable material from brine would not go well as a part of a small fish business but, having its own peculiar problems, would be more properly conducted as a separate business. In any event, this promising subject is commended to the chemists and engineers for study. We can not doubt that a few years will bring forth a complete solution of the problem of recovering things of value from brine that will make us wonder why we ever threw it away.

ACCESSORY CHEMICAL AGENTS AND OTHER FACTORS IN SALTING.

Various other chemicals are sometimes used in salt or along with it for various purposes. Some of these will be briefly discussed.

Saltpeter performs two functions in brine for the preservation of meat, namely, it combines with the red substance of blood, hemoglobin, which is unstable, to form a permanently stable red derivative, nitroso-hemoglobin. By virtue of its oxidizing power it may also oxidize hydrogen sulphide into sulphur dioxide and water; that is, a very foully odoriferous stuff to a substance which both bleaches and sterilizes. Saltpeter is, however, little used in curing fish, for the red color is undesirable, and hydrogen sulphide is rarely troublesome.

Boric or boracic acid is sometimes added to the final application of salt to dried salt cod. This is to prevent reddening. Undoubtedly it does do so, and undoubtedly most of it is removed from the fish when the latter is soaked up before cooking. Nevertheless, it seems that the end of this practice is not distant. Boric acid has long ago been condemned as a food preservative. With the comparatively small amount of scientific investigation that has already been done we have reason to hope that not only can reddening be prevented, but that by the general refinement and improvement of methods it will become unnecessary to use artificial preservatives to prevent reddening.

A method of promoting the preservation of fish by salt by the aid of sodium hypochlorite along with the salt has been patented. The original idea, it is understood, was to decompose the salt in sea water by electrolysis, sodium hypochlorite being formed. It was claimed that the sodium hypochlorite penetrates faster than ordinary salt. This substance contains some oxygen that may be given off to act as a sterilizing agent, and after the oxygen is given off ordinary salt or sodium chloride remains. What advantages the process possessed are not altogether apparent, for nothing appears to have come of it. It may be said, however, that sodium hypochlorite readily destroys urea, so that this substance might be advantageous in the preservation of grayfish and sharks but is unstable and must be used as soon as it is made.

The size and shape of the fish obviously have much to do with the time required for salt to penetrate through. Salt effects no preservation of parts until it reaches them. A thick fish may spoil, while a thin fish may be saved; hence the splitting of fish. Other methods of applying the salt to the inner parts of fish may be used, such as a needle syringe, whereby the brine is forced into the tissues, and compressed air, which is used to force brine into fish after the excess air has been removed from them in vacuo. It should also be possible

to insert a needle in the gill arch and with pressure completely irrigate the whole system of arteries and veins of a fish, removing absolutely all the blood at one stroke without cutting the fish.

CONCLUSIONS.

The preservation of fish by means of salt is an excellent method, even in the crude and inexact manner in which the art has hitherto been practiced. The comparatively small amount of scientific research that has been done on the problems and principles involved has not only justified itself in practice but furnishes abundant grounds for the expectation that a great deal more of valuable results will follow further work. It is not mere guessing to say that when advantage is taken of all that is known of improved salting methods a fish nearly if not quite equal in edible qualities to fresh fish is obtained, and in some cases the quality is decidedly improved by salting.

There is every reason to expect a good future for the salt fish industry, but progress must be made. Preservation by this method is eminently practicable, simple, and reliable for holding and transporting our sea fishes to the inland population.

SUMMARY.

1. A discussion of the principles involved in the preservation of fish by salt has been presented.

2. Salt possesses no inherently peculiar preserving qualities, but preserves food by extracting water.

3. The principle by which salt (and other soluble substances) in concentrated solution extracts water is called osmosis. Osmosis is the passage or interchange of liquids and solutions through membranes which are more or less permeable. The permeability of cell membranes in fishes appears to be affected by high and low temperatures. The presence in or absence from the salt of certain impurities, notably calcium and magnesium compounds, the treatment of the fish, and the staleness of the fish, are factors which govern the permeability and have an important bearing on the preservation of fish by salt.

4. Calcium and magnesium compounds in addition to retarding penetration cause a whitening and hardening of the fish. There are chemical reasons for looking upon this whitening and hardening by these compounds as undesirable.

5. The flavor of fish is often altered by the salting process. Calcium salts retained in the tissue increase the salty taste and make necessary a prolonged soaking out. Undesirable flavors of fishes from muddy waters may sometimes be removed by salting the fish.

6. Salt applied dry penetrates the fish more rapidly and effects a quicker cure with less danger of spoilage in warm weather.

7. There is a very material loss of protein material from fish during the salting process. This material probably arises from the decomposition products ordinarily unable to pass out of the cells but which are digested by autolysis, an internal destructive process.

8. Autolysis is increased by crushing, bruising, rough handling, pewing, elevated temperatures, low temperatures followed by a rise, and, in general by factors that increase cell permeability. It is

retarded or arrested by continued low temperatures, sufficiently high temperatures, and by salt.

9. The damage done by autolysis appears to be in large part preventable.

10. Fish containing blood, or otherwise not well cleaned, spoil at a lower temperature than those thoroughly cleaned and freed from blood. Thoroughly cleaned fish may be salted at from 90 to 100° F. if pure salt is used.

11. A method of curing fish embodying the improvements cited was tried in Florida on a small commercial scale with gratifying success.

12. Scotch-cured herring develop a peculiar flavor which is derived from the fermented or otherwise altered blood. This method has for its aim an alteration to suit particular tastes, while other methods of salting discussed aim at the preservation of the fresh qualities of fish.

13. There are reasons for expecting that the improvements made in the salting of other fish, particularly those which depend on the use of a very pure salt, will find application in the mild curing of salmon.

14. Fats undergo certain changes after the fish is salted, resulting in a condition known as "rusting." Rusting consists of oxidation of fat after the latter has been split into free fatty acids. This splitting is caused by tissue enzymes in the presence of warmth and moisture. Oxidation is brought about through the agency of light in the presence of water. While rusting causes large losses of fish, the means of preventing it, such as tight barrels, air-tight covering, and cool dark storage, are not very satisfactory. The problem demands further investigation.

15. Fishes whose flesh is not fat and therefore not prone to rust are subject to damage by reddening. Reddening is caused by two organisms, a spirochaete and a bacillus. They may be destroyed by fresh water or live steam. They originate probably in solar sea salt and are apparently not found in mined salt or other purified American salt.

16. Some work has been done toward the development of a process for recovery of salt and other valuable materials from brine. There are a number of promising possibilities which should make this an attractive field for chemists and engineers.

17. Certain substances are sometimes used as adjuncts in salting fish. Saltpeter preserves a pink color and neutralizes hydrogen sulphide. Boric acid is used for preserving cod against reddening. Sodium hypochlorite has been proposed as advantageous in conjunction with salt. It may be produced electrolytically from sea water.

18. The size and shape of the fish influences the rate of penetration of salt into it. Certain mechanical methods of forcing brine into large fish may be advantageous.

FIG. 1.—"KITCHEN MIDDEN," OR BANK OF SHELLS, NORTH OF YACHATS, OREG.

These shell heaps were made by the Indians many years ago and represent places where mollusks were prepared for food. The shells, for the most part, are of the species of mollusks existing in the vicinity to-day. "Kitchen middens" are common along the Northwest coast.

FIG. 2.—EAST SHORE OF WEST ARM OF COOS BAY, LOOKING NORTH TOWARD EMPIRE CITY.

This portion of the bay supports *Schizothaerus nuttalli*, the "great blue clam" (fig. 6), *Cardium corbis*, the "cockle" (fig. 12), and *Paphya staminea*, the "little neck clam" (fig. 8). None of these, however, is very plentiful in the bay. *Mya arenaria*, the "eastern mud clam" (fig. 4), is abundant in another part of the bay. See discussion under the Coos Bay Region, beginning on page 3.

SHELLFISH RESOURCES OF THE NORTHWEST COAST OF THE UNITED STATES.[1]

By Charles H. Edmondson,

Temporary Assistant, U. S. Bureau of Fisheries, 1917–1919.

CONTENTS.

INTRODUCTION.

During the summer of 1917 the writer was appointed as temporary assistant by the United States Bureau of Fisheries, which services were renewed during the summer of 1918 and continued at intervals through May, 1919. The specific purpose of the appointment was to make a survey of the shellfish resources of the northwest coast of the United States, including the shore line, bays, and rivers of the State of Oregon and the southern portion of Washington.

The undertaking being in the nature of a war measure, with the ultimate purpose of food conservation in view, it was considered advisable to first make a survey of the coastal region in order to determine the varieties of shellfish existing, their relative abundance, and their accessibility to markets or centers from which they might be distributed, and to encourage the more general use of such sea foods as clams, oysters, mussels, and other shellfish.

It was also deemed advisable to make studies of the spawning seasons of the common edible shellfish and learn, if possible, something of their rate of growth and the conditions under which they best thrive, that such information might be available in the future should it at any time be considered wise to undertake the cultivation of certain species of shellfish or to place further restrictions upon the present rate of destruction.

[1] Appendix III to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 920.

The first section of the northwest coast surveyed extended from the mouth of the Siuslaw River, in Lane County, Oreg., to Tillamook Bay, in Tillamook County, of the same State. This survey was made during a period of 17 days and included a hasty investigation of the location and distribution of beds of clams and mussels, the determination of the species of shellfish contained therein, and other information and observations which might serve as a basis for later and more intensive work.

Among the rivers and bays of more or less importance in shellfish resources, this stretch of coast line includes the Siuslaw River, one of the larger rivers of Oregon, the Yachats River with a small bay at its mouth, Alsea Bay, the Yaquina River and Bay, Siletz Bay, Nestugga Bay, Netarts Bay, and Tillamook Bay. Besides the above, long or short sand beaches alternate with rocky points and rugged headlands, each serving as habitats for certain forms of shellfish.

The above coast line was traversed, for the most part, on foot, as that seemed to be the most efficient means of acquiring the desired information relative to the location and distribution of species of shellfish. This region of the Oregon coast, as can be said of practically the entire length of it, is very sparsely settled, with public roads paralleling the coast line either in very poor condition or absent altogether. In not a few places the public highway is the sand beach, a splendid roadway at low tide but dangerous or quite impassable at high tide. Trails may usually be found leading over or around headlands, but frequently these are overgrown and indistinct, due to lack of use.

The principal villages and settlements throughout the extent of the Oregon coast from the Siuslaw River to Tillamook Bay include the town of Florence on the Siuslaw River, about 4 miles from its mouth, a few scattering houses at Heceta Head, the village of Yachats at the mouth of the Yachats River, the town of Waldport on Alsea Bay, Newport on Yaquina Bay, Taft on Siletz Bay, Pacific City on Nestugga Bay, Netarts on Netarts Bay, and Tillamook City on Tillamook Bay. Interspersed with the settlements mentioned above are a few ranch houses where the nature of the immediate coastal region permits farming on a small scale.

The physical conditions, the settlements, and the means of communication of the above section are mentioned in detail, as these facts have considerable bearing upon the accessibility or lack of accessibility, as the case may be, of certain shellfish resources on this coast, and their values as market products.

At later periods during the summer, fall, and winter of 1917 surveys were made of the southern shore of the State of Oregon to a distance of about 5 miles south of Bandon, a town at the mouth of the Coquille River, with special attention given to the Coos Bay region. Investigations of the northwest section of the coast of Oregon were also made during 1917 and also the following year. These latter surveys extended from Tillamook Bay northward, including the Nehalem coast beaches, Cannon Beach, the Clatsop County beaches, opposite the towns of Seaside and Gearheart, and on to the mouth of the Columbia River. Surveys were also made of the beaches on the Washington coast up to Willapa Bay. The shellfish resources of this bay were investigated, approaching it from both

the west side by way of Nahcotta and the east side by way of South Bend. Olympia, Wash., was visited for information relative to the shellfish resources of the southern Puget Sound region.

Since the coastal territory covered in these investigations is so extensive and so varied in character of its geography it naturally resolves itself into a number of more or less distinct shellfish centers, each with some characteristics peculiar to itself.

For purposes of system and convenience in this report, six more important shellfish centers or regions will be discussed under separate headings. Following these, consideration is given to localities of minor importance. The species of shellfish found in each region and their distribution, relative abundance, and importance are indicated, together with such other investigations and observations as were made during the course of the survey. The photographs included in the report are illustrative of some of the regions discussed and of the typical shellfish of the Northwest. A summary and conclusions are to be found at the end of the report.

SHELLFISH RESOURCES OF MAJOR IMPORTANCE.

THE COOS BAY REGION.

Coos Bay, in Coos County, Oreg., is one of the larger bays of that State. It is shaped like an inverted V with the apex directed northward and the outlet of the bay toward the lower end of the left arm. Near the head of the bay, Coos River and other smaller streams feed it with fresh water and much silt from the surrounding territory. In parts of the bay on either side of the navigation channel are broad mud flats, exposed or nearly so during reasonably low tides.

On these broad mud flats a number of species of edible clams have become well adapted to their surroundings. Extensive beds of *Mya arenaria* Linnaeus, the eastern mud clam, are to be found on the north side of the channel opposite the town of North Bend. During favorable conditions of weather the channel can be crossed by a rowboat and the clams transported to North Bend or Marshfield, an adjoining town. Here *Mya arenaria* grows to a fair size and is present in considerable abundance.

During 1917 and for several years previous to that date Frank LaRue supplied the local demands for this shellfish. No attempt was made by Mr. LaRue to develop outside markets for the clam, as he believed that Mya could not be obtained in sufficient quantities in Coos Bay for both local and export trade. In 1917 the local price received for Mya was $0.75 per 5-gallon can of fresh clams, including shells.

Early in 1918 Samuel Terrill came to North Bend from Florence, Oreg., and established a market for shellfish and other sea products. This permanent place of business, with a supply of clams, crabs, etc., on display where the public might see them, was an apparent stimulus to their use as articles of food. Mr. Terrill was carrying on a good business locally during the fall of 1918. He made little or no attempt to place clams on the markets of Willamette Valley towns, although there is direct communication by rail with Portland and intermediate points, the time required for transportation by express from North Bend to Portland being about 12 hours. The

Willamette Valley, however, as is noted in a later section of this report, is supplied with shellfish from another source.

In Marshfield, a town adjoining North Bend but of greater population than the latter, the shellfish trade is also good, the hotels, restaurants, and other patrons being supplied by a local meat concern which employs its own clam diggers. Owing to its greater relative abundance, *Mya arenaria* is the only clam found on the markets in any quantity in and about the Coos Bay region.

Southward from Empire City, a small town on the west arm of Coos Bay, and especially on the east side of the channel are distributed other species of shellfish of edible quality, although not found in large numbers. Well up toward Empire City, in 1917 and 1918, small quantities of *Schizothaerus nuttalli* Conrad, the "great blue clam," were to be found. Few of these reach the markets of North Bend or Marshfield. *Paphya staminea* (Conrad) also occurs in small numbers below Empire City on the east side of the channel, extending into South Slough at the southern end of this arm of the bay. This species grows to a moderate size here but is nowhere abundant, and little profit would accrue in attempting to market the species from this source.

During the summer of 1918 a small shipment of Paphya was made from Coos Bay to the Siuslaw River, in Lane County, in an attempt to establish the species in that locality. The experiment was not successful. In Coos Bay the species lives just beneath the surface of ooze and is fairly well covered with masses of seaweed. In the Siuslaw River it was found necessary to plant it in a more exposed locality free from seaweed. Whether this greater drainage at low tide had a disastrous effect upon the species can not be determined, as no further attempts were made to transplant this clam.

Associated with *Paphya staminea* in this region is found *Cardium corbis* Martyn, the "cockle." It exists here under similar conditions as Paphya and is scattered in a very general manner. The species is a negligible factor as a food product in this locality.

The prospect for the success of oyster culture in Coos Bay is promising. Fourteen acres have been set aside by a group of local men interested in the enterprise and planted with the western oyster, *Ostrea lurida* Carpenter. The season of 1917 proved to be a successful one. A satisfactory amount of spat was collected, which gave encouragement to the project and led to the consideration of a material increase in the acreage. The season of 1918 was also reported to be successful. The writer was able to advise regarding materials for cultch and encouraged the extension of the plantation. He entered into correspondence with the U. S. Bureau of Fisheries relative to the planting of western oysters in Coos Bay on a larger scale than could be undertaken by the private parties of North Bend. It was not deemed advisable at that time, however, to undertake the project.

At one time Coos Bay evidently supported the western oyster in great abundance, if one can judge from the quantities of shells that are cast out of the bed of the bay by the activities of the steam dredgers. These oysters became extinct, however, many years ago. The cause of the extinction is not positively known. The Indians believe it was a result of a great forest fire which swept the Oregon coast nearly 100 years ago.

Cape Arago and Sunset Bay are a short distance south of the Coos Bay bar and, while included in this region, may be dismissed with brief consideration. The chief economic Mollusca of this rocky point and small bay, of which mention need be made, are two species of sea mussels, *Mytilus edulis* Linnaeus and *Mytilus californianus* Conrad, the latter being of much larger size, when adult, and possessing a rougher shell than the former. The larger species is the more characteristic of the outer rocks where the waves are strong. Although these two species are plentiful in the vicinity of Cape Arago they are seldom used as food.

Experimental investigations carried on in the Coos Bay region included studies concerned with the determination of the spawning seasons of certain clams and mussels inhabiting those waters. It was believed that microscopic examination of the ovaries and spermaries of large numbers of individuals of a given species through as many months or seasons of the year as possible would reveal the limitations of the spawning period or periods of that species. Such investigations in the Coos Bay locality comprised work upon *Paphya staminea*, *Cardium corbis*, and *Mytilus edulis*. As a result of these observations it can be said with assurance that *Paphya staminea* spawns in this region during the late summer and early fall, or during the months of August and September. No definite assertion regarding the spawning of *Cardium corbis* or *Mytilus edulis* could be made after many examinations at North Bend during the periods spent there in 1917 and 1918.

THE SIUSLAW REGION.

The Siuslaw River flows into the Pacific Ocean in western Lane County, Oreg. It is a broad, expansive river for more than 10 miles from its mouth and the influence of salt water is felt for about twice that distance during high tides. About 4 miles from the mouth of the river are the towns of Florence, on the north bank, and Glendale, on the opposite side. The village of Acme is a few miles up the river on the same side as Florence. Between these two towns, mostly on the north side of the channel of the river, are some excellent beds of *Mya arenaria*, the eastern mud clam. The writer has examined beds of this species in many localities of the northwest but no finer specimens of Mya have come to his notice anywhere than those found near Florence. The beds here occupy mud flats which are very accessible from the shore and are uncovered during a moderately low tide.

No other economic mollusk is associated with *Mya arenaria* here. In this respect the Siuslaw River flats differ from others of this State. Even *Schizothaerus nuttalli*, the "great blue clam," common both to the south and north of this region, has not gained a foothold here. *Mya arenaria* was carried to the Siuslaw River from Coos Bay by one David Morse more than 30 years ago and has done exceedingly well in this locality.

That food is sufficient for the mollusks may be indicated by the large size which they may attain in this environment. The author has measured numerous shells from these beds which were well over 6 inches in length. That the waters are well supplied with microorganisms which serve as food for the clams is shown by opening the

stomachs of the mollusks immediately after they have ceased feeding, as the tide recedes. Diatoms, Protozoa, and other microorganisms are found to make up a substantial portion of the stomach contents.

During the summer of 1917, when the writer first made observations on the clam beds of this region, Samuel Terrill, mentioned above, was engaged in digging clams for the local demand as well as for export to Willamette Valley towns. Four miles above Florence at Cushman, a station on the Siuslaw River, direct railroad connections may be had with Portland and intermediate points, the time required to Eugene, where a good many clams were shipped, being about three hours, and to Portland between seven and eight hours. Clams taken in the Siuslaw River during an early morning tide would be delivered to the market or consumer in Eugene, Albany, or Salem the evening of the same day, and early the next morning in Portland. This railroad connection had much to do with stimulating the shellfiesh markets of the Willamette Valley towns mentioned above.

Although certain portions of the clam beds near Florence had been systematically worked over in years previous to 1917, at this latter time areas comprising 25 acres or more on the north side of the channel of the river and about one-fifth that area on the south side were well stocked with clams. The mollusks were doing much better in the rich, deep mud well out in the middle of the beds than they were nearer the shore where the soil was more sandy in character and where a longer exposure between tides reduced the duration of feeding periods.

It was gratifying to find in 1917 that the clams were being used extensively by the people of that locality and of near-by towns. Mr. Terrill during that year was able to make a fair income by working the clam beds for local demands and for shipments to the markets of Williamette Valley towns. The 5-gallon oil can was used as a standard of measurement for clams, for which quantity 50 cents was the regular price. On a favorable tide Mr. Terrill was able to dig from five to eight cans of clams. It is estimated that the clam beds near Florence would net one who could devote most of his time to this industry from $1,000 to $1,500 annually. Early in 1918, Mr. Terrill, believing that he could do better financially in a larger town, established a permanent place of business in the town of North Bend, on Coos Bay, where he now supplies the local demand for clams and other sea foods.

The removal of Mr. Terrill left no responsible person in charge of the digging and marketing of clams from this region. Others took up clam digging on a small scale, but were not able to devote much time to it, and as a result in 1918 the export shipments of clams from the Siuslaw River were much curtailed. There was even a scarcity of this food product in Florence. It was observed here, as elsewhere, that many families will make use of clams if they are delivered at the door, but few will take the trouble to go and dig them, although conveniently at hand.

The writer made use of the clam beds of the Siuslaw River during the period from August, 1917, to May, 1919, for experimental work upon the spawning period, the growth, and the shipping qualities of *Mya arenaria*.

An estimated census of the clams was taken in 1917. In the most densely populated areas, from 25 to 30 claims per square yard were often taken, with the number frequently reaching 50. From the point of maximum yield in bed the number was reduced to few or none per square yard as the shore line was approached. Local residents who had observed the clam beds in the Siuslaw River for many years believed in 1917 that there was no appreciable reduction in the abundance of clams from season to season. It is the author's opinion, after viewing the beds at intervals for nearly two years that, although certain areas which in past years were systematically worked over and exhausted have not restocked themselves, the clams are holding their own fairly well.

Sudden catastrophies have occurred, however, and may occur again to inhibit the natural development of the clams in the Siuslaw River. The North Fork, a tributary of the Siuslaw River, flows into the latter about 1½ miles above Florence, near the upper end of the clam beds., During December, 1917, and January, 1918, excessively hard rains filled all of the mountain streams tributary to the Siuslaw River and for nearly two months this river and the North Fork were overflowing their banks. An immense amount of silt was carried down the streams and deposited over the clam beds. During that time the clams were continuously under this flow of fresh water, and when next observed, late in January, 1918, it was found that large numbers of the young clams, which in the preceding December had measured from 10 to 25 millimeters in length, had perished. Medium-sized and large clams were uninjured, but the small ones situated near the surface could not maintain themselves. Their appearance was similar to that assumed by other clams of the same species killed in fresh water during experimental investigations. This destruction resulted in a noticeable reduction of half-grown clams in the beds in the following summer. Although heavy rains are characteristic in western Oregon during the winter months, rarely are floods of so long duration as they were in December, 1917, and January, 1918, and similar destruction of young clams probably seldom occurs.

That *Mya arenaria* spawns in late August and during September on the Oregon coast is well established. In the early part of September, 1917, an examination of the ovaries and spermaries of the species was made at Florence. The clams were found to be in spawning condition with mature ova and very active sperm. These observations were verified during the corresponding season of 1918. That spawning does not occur at other seasons of the year was also demonstrated by repeated microscopic examinations of the gonads of the species during nearly every month of the year.

Portions of the clam beds of the Siuslaw River were, in 1917, well covered with eel grass which gave support to the glochidia, as was apparent by turning over the upper layers of mud in which the eel grass was rooted. Here during late November and early December, 1917, were to be found large numbers of young clams from 10 to 25 millimeters in length in the surface of the ooze beneath patches of the eel grass. Spawning in late August or September, apparently young clams may reach a length of 25 millimeters by December if conditions are favorable.

It was also shown by repeated experiments on the rate of growth of Mya that young clams 25 millimeters in length will, in favorable positions in the bed, double their length in six months' time, or reach a length of 50 millimeters. How long the clams will continue to live and grow has not been demonstrated here. It is estimated, however, that the larger clams of these beds, those of a length of 6 inches or more, are probably more than 5 years of age.

Attempts were made to restock depleted areas of the beds by replanting young and medium-sized clams. These efforts were, for the most part, successful. It was demonstrated, however, that success could not be attained by planting too near the shore, or in too exposed areas, or in localities where the soil consisted of sand with small amounts of black mud. The lack of food was probably a deciding factor under these conditions. Young and medium-sized clams when transplanted in the rich, black mud readily took hold. The planting was accomplished by digging holes in the mud with a pointed stick and dropping the clams in with the siphons up. If large clams were planted, it was found advisable to set them about 1 foot below the surface, as they did not readily dig much deeper than they were placed, and if left too near the surface they usually perished.

Shipments of *Mya arenaria* were frequently made during all seasons of the year from Florence to Eugene in order to test the shipping and keeping qualities of the clam under varied conditions. If kept in a warm dry place, the clams will soon die, usually within 24 hours. By reducing the temperature of the container in which the clams are kept to near the freezing point, they have been found in good condition at the end of a week, and they have been kept alive for 14 days by being placed directly in contact with the ice. It is obvious that *Mya arenaria* is a good shipper under proper conditions. If transported in refrigerator cars properly iced, there is every reason to believe that Mya might be shipped several hundred miles and still be fit for the market.

The writer encouraged the use of Mya as a substitute for the red meats in various parts of the Willamette Valley and was gratified to find an increased response on the part of the public in spite of the widespread prejudice against "things that grow in the mud." A number of lectures were given by the writer on the sea-food resources of our northwest coast and the newspapers were used in stimulating an interest in shellfish as food.

The only other bivalve which may be considered of economic importance appearing in the Siuslaw region is *Mytilus edulis.* It is not uncommon on the rocks at the mouth of the river and advances at least 4 miles up the stream from its mouth. No attention, however, is given to the mussel in this locality.

THE YAQUINA REGION.

The Yaquina region includes the Yaquina River, Yaquina Bay, and the beaches immediately to the north and south of the latter. While the preceding region was characterized by the presence of a single edible clam, besides a sea mussel, here are no less than six species of mollusks besides the western oyster and two sea mussels,

which are used to a greater or less extent as articles of human food. The region is a large and extensive one, comprising long stretches of ocean beaches, a broad bay, and several miles of the Yaquina River with its muddy margins exposed at low tide.

No single clam can be said to be characteristic of this region. *Schizothaerus nuttalli*, the "great blue clam," is abundant on both sides of the river between the towns of Newport and Yaquina. It lives in the soft mud here and is easily removed, as it is quite near the surface, which is unusual for this species. The "great blue clam" is one of the principal clams used as food by local consumers.

In 1917, when the writer first made observations on the shellfish of this locality, Messrs. Reeves and Doig, fishermen who lived on the bank of the Yaquina River, chiefly supplied the people of the town of Newport with shellfish. Local fish markets also handled the product and there was a brisk demand and a supply always on hand.

Associated with "the great blue clam," but more abundant on the south side of the channel, are *Cardium corbis*, the "cockle," and *Paphya staminea*, the "little neck clam." These are also used by local consumers to a considerable extent. *Macoma nasuta*, the "bent nose clam," was quite abundant on the north side of the bay in 1917 and 1918. This clam was found to be used as food to a limited degree. Those who were accustomed to make use of it commended its flavor very highly, stating that it was more like the oyster than any of the others. For this reason it has been given a local name of "oyster clam." One of the chief objections to this small clam is that it ingests so much sand that it is somewhat disagreeable if prepared immediately after having been removed from the water. If the clam is placed in clean fresh water, however, a short time before it is to be prepared, most of the sand will be ejected and the clam will be much more desirable as food.

Mya arenaria is also found on the markets of Newport and is much sought after by shellfish consumers. The species is taken from the river above the town of Yaquina and brought down to the Newport markets at irregular intervals, but usually two or three times every week.

The beach immediately north of the mouth of the Yaquina River, known as Nye Beach, is abundantly supplied with a rock borer, *Pholadidea penita* (Conrad), which is considered a great delicacy by local consumers of shellfish. The soft sandstone rocks which parallel the beach and are exposed at low tide offer favorable habitats for this bivalve. The species occurs at other localities along the northwest coast, but this region may be considered a center of great production. Tourists who spend a few months at Newport during the summer frequent the beach at low tide to break out the rock borers with pick and crowbar. There is great destruction of the young mollusks as well as of the old, as a result, and the species in the rocks near the shore was apparently well depleted in 1918. How long the species will survive here is a question which can not now be answered as its life history and rate of growth have not been determined.

Sea mussels thickly cover the rocks of the north jetty at the mouth of the river, those that stand out from the shore at the north end

of Nye Beach and those about the base of Yaquina Head. They are also common on Seal Rocks 10 miles to the south of Yaquina Bay. Two species of mussels are found in this region, *Mytilus edulis* and *Mytilus californianus.*

Formerly the razor clam, *Siliqua patula,* was very abundant in the ocean beaches of the Yaquina region. As late as 1914 and 1915 large quantities of this clam were obtainable both north and south of the bay. No very satisfactory reason can be given for the rather sudden disappearance of the clam south of the Clatsop County beaches. After careful observation of the beaches formerly populated by the razor clam in this region and elsewhere the author is inclined to the opinion that the shifting of the sand has been a large factor in the disappearance of the clams either by smothering them or by washing them out into deeper water. A great many of the clams have been destroyed in the past few years as is evidenced by the quantities of shells that are cast up on the beaches. If they have been washed out into deeper water there is a possibility that they may return by inshore migrations. It was gratifying to find during the summer of 1919 that the razor clam was apparently coming back at a number of points along the Oregon coast, as will be noted in a later section.

The Yaquina River is the center of the oyster industry in Oregon. The most productive areas are about 1 mile above the town of Yaquina near Oysterville. They include both natural and private beds. The natural beds are under the control of the State Fish and Game Commission which prescribes rules and regulations for the protection of the beds and for the taking of the oysters. The closed season as to natural beds has been fixed by statute, being from the 15th day of June to the 10th day of September of each year.[2]

Certain areas are set apart and designated by law as beds for the artificial planting of oysters. Such beds are limited in size, not to exceed 2 acres in each plantation, and each holder of a claim is required to comply with local regulations fixed by the association of oystermen.[3]

Since the beds are, for the most part, located in the channel of the river, in 1917 the fishermen on the artificial plantations were having considerable difficulty, as had been the case in previous years, in preventing the oysters from being smothered by the sediment carried down the river. Frequent tonging was resorted to to keep the silt moving. Little or no artificial methods were resorted to in order to catch the spat. The old shells were considered, by those engaged in the industry, as sufficient cultch with the occasional help of the bark of trees.

In spite of the fact that the Yaquina oyster fishermen have certain natural difficulties to contend with, they made a fair profit during the season of 1916–17. At that time 15 men were engaged in oyster fishing. By working diligently each man was able to take from four to six sacks per week, the standard sack being 110 pounds, including shells. During that season the price realized in Portland, where nearly all of the oysters were marketed, was from $6 to $8 per sack. This price of the Yaquina oyster was somewhat

[2] Fish and Game Laws of Oregon, 1919–20, sec. 187, p. 76.
[3] Fish and Game Laws of Oregon, 1919–20, sec. 186, p. 76.

in advance of that of previous years, due to the curtailment of the supply of oysters in the Northwest, resulting from a partial destruction of the beds of the Puget Sound region by freezing during a previous season.

In 1897 the eastern oyster was introduced into Oregon. The Yaquina River was selected as the most favorable locality for the growth and possible development of the species. Plantings were made near Oysterville and cared for under the direction of the State biologist for a number of years, during which time the oysters grew and matured. It was reported that spawning occurred, but the hope of collecting spat was given up after the failures of several seasons in the belief that the water was too cold.

Investigations looking toward the determination of the spawning seasons of the clams and mussels of this region were conducted at intervals during the summer, winter, and spring months with the result that *Schizothaerus nuttalli*, the "great blue clam," was found to be spawning during the month of March, the limits of the period probably being from the last of February or the first of March to well along in April. At no other season was the species found to be spawning although examinations were made during other months of the year in this locality and elsewhere.

Paphya staminea was found to be in a spawning condition during the month of March at Yaquina, while the species was found in a similar condition in Coos Bay during the late summer and early fall. The hermaphroditic character of *Cardium corbis* was first observed during the month of March in this locality. That spawning of this species occurs here in the spring months can hardly be doubted. No positive assertion could be made regarding the spawning periods of other species of clams and mussels investigated here.

The trial shipments of *Schizothaerus nuttalli*, *Cardium corbis*, and *Paphya staminea* were made from Newport to Eugene, Oreg., at intervals during the winter months of 1918. These were made to determine the shipping qualities of the different species and enabled the author to reach conclusions as to the marketable value of the clams, in fresh condition, at points some distance from the source of supply. The time required by express from Newport to Eugene is usually seven or eight hours, with one transfer.

Schizothaerus does not ship well. Its shell is quite brittle and is often broken into fragments in transit. The clam is a "gaper," the adductor muscles relaxing soon after the animal is removed from the salt water, permitting the shell to open widely. Cold-storage methods were not successful in preserving this clam in an edible condition for more than three or four days. Advice given to the public was to prepare the "great blue clam" for use as soon as possible after it was taken, otherwise it might prove to be a dangerous food.

Much of what has been said about the previous species may be said of *Cardium corbis*. The shell of the "cockle," however, will withstand the shocks of transportation, but the clam is also a "gaper" and can hardly be relied upon as food after being out of water for 24 hours, unless placed upon ice, which method may preserve it safely for another day. The species is an excellent one for local consumption, but can not be counted upon for shipment in a fresh condition.

Paphya staminea is a good shipper, but can not be taken in this locality in sufficient abundance to make it profitable for other than local use.

The conclusion arrived at in 1918 was that there were no species of clams or mussels in the Yaquina region that were obtainable in large enough quantities and that had the proper shipping qualities for purposes of commerce, in the fresh condition, beyond the local demand.

Messrs. Reeves and Doig, mentioned above, in 1917 carried on a small export trade in canned clams shipped direct to consumers in Willamette Valley towns, the method being to seal the edible portions of the clams in jars of fresh water, the cooking to take place when the destination was reached. This did not prove to be a very popular way of handling the product and was not long continued.

It was gratifying, however, to find that large quantities of shellfish, including clams, crabs, oysters, etc., were used locally in and about the Yaquina region. The people of that locality were, for the most part, fully aware of the value of the sea-food products conveniently at hand.

In the spring of 1918, after advising with the office of the U. S. Commissioner of Fisheries, a shipment of "pismo" clams was obtained from San Luis Obispo Bay, Calif., and planted in the Yaquina region between Nye Beach and Agate Beach. Through the efforts of the California Fish and Game Commission 750 pounds of the clams were secured and shipped. They arrived at their destination apparently in good condition and were planted on a beach which, in the author's judgment, was well suited to them. Several days after the planting occurred, a single clam was found about 200 yards from the place of planting. The clam was alive, in the edge of the water and half covered with sand. This led to the belief that more of the clams may have become scattered up and down the beach, although no others were located. In 1919, a year after the planting, no sign of any of the clams could be discovered, nor were any shells to be found along the beach. The success or the failure of the project can not be determined at this date.

NETARTS AND TILLAMOOK REGIONS.

These two shellfish centers in Tillamook County, Oreg., may be considered as one. Netarts Bay is a long but very shallow arm of the sea, with the outlet some miles north of Cape Lookout. The bay is so shallow that during an extremely low tide nearly all of the water runs out, leaving much of the bottom area exposed. The salinity of the bay is essentially that of the ocean, as practically no fresh water enters it.

The bay supports a number of species of edible shellfish, among the clams being *Schizothaerus nuttalli*, *Cardium corbis*, *Paphya staminea*, and *Saxidomus giganteus* Deshayes. Schizothaerus predominates and seems to show little or no evidence of depletion from year to year. The species occupies the gravel beds of several acres in extent at the north end of the bay near the outlet, which are very accessible from the shore. The clams are very abundant here, but are quite firmly embedded in the gravel, and are more difficult to remove than in those localities where they inhabit soft mud.

Cardium and Paphya are associated with Schizothaerus, but are much less numerous than the latter, their scarcity rendering them of small significance as food products in this region.

Saxidomus giganteus, a very excellent food mollusk, was formerly very abundant in Netarts Bay, but has become greatly depleted in recent years. This depletion was more apparent during the summer of 1918 than during the previous year. Excessive digging of the clam seemed to be the chief factor making for its extinction.

In former years the razor clam, *Siliqua patula*, was a familiar species along the ocean beaches outside of Netarts Bay as well as within the bay. In 1917 practically no razor clams were found along the open ocean beaches in this region, and the same conditions persisted in 1918, but each year a few have been taken from the sand beds in the bay proper.

This region is one of the most fertile in the production of the large sea mussel, *Mytilus californianus* Conrad, of any part of the territory surveyed. The coast north of Netarts Bay, in the vicinity of Cape Mears, is very rugged. Here large areas of the rocks are densely covered with masses of this large mussel. Aside from a very insignificant local consumption as food, the immense beds of sea mussels here and elsewhere along our northwest coast have not as yet been turned into any economic value.

During most of the year the village of Netarts, on Netarts Bay, consists of a few scattered houses of permanent residents, but in the summer season it becomes a tent town of considerable size. From June until September, during the years 1917 and 1918, many people from inland districts of Oregon and other States visited Netarts for periods of from one week to a month or more. While there, clams were a constant article of diet, and nearly every family canned quantities of the shellfish to be carried away for future consumption.

Netarts is in an isolated region and at times is almost or wholly cut off from communication with inland points, due to the bad condition of the highway. During the rainy season of 1918 the road from Tillamook City to Netarts was, at times, entirely impassable for wheeled vehicles. With the improvement of means of transportation from this region markets may more easily be established for such species of shellfish as are suitable for distribution at points some distance from the coast. The markets of Tillamook City, 9 miles from Netarts, are supplied in part from Netarts Bay, but the quantity of fresh clams shipped from Netarts to more distant points is not large. Portland is from 8 to 10 hours by rail from Tillamook City, and to reach the upper Willamette Valley towns requires an additional 4 or 5 hours, after one transfer is made.

On consideration of the quality of the clams that were available for export from Netarts Bay in 1918 and the uncertain means of transportation, it was not deemed wise to encourage the shipment of this product to inland markets.

Trial shipments of *Saxidomus giganteus* and *Schizothaerus nuttalli* were made from Netarts to Eugene at various times of the year. Saxidomus is a very good shipper. The shell is heavy and firm and the adductor muscles contract strongly when the clam is removed from the water and remain in that condition for a long

time. As far as the keeping qualities of this clam are concerned it could be marketed from Netarts Bay in many of the inland towns of the State within two days by express if the means of transportation from the source were more certain. The author has been able to keep Saxidomus for a week in good condition by placing it in an ice chest.

The depletion of *Saxidomus giganteus* in Netarts Bay during the summer of 1918, however, prevented any further attempt to secure markets for this species. Advice was given local diggers during August of that year to discontinue the taking of Saxidomus for a period of two or three years in order to give the clam a chance to restore itself. This was recognized by some as a proper method, but there was nothing to prevent many other people from taking the species whenever they had opportunity.

The conclusion formed after numerous shipments of Schizothaerus from Netarts to Eugene was that this species could not be depended upon to come through in good condition. The same limitations were found to exist as in case of shipments from the Yaquina region. Danger from slow and uncertain transportation, the fragility of the shell, and the gaping nature of the clam inhibited the possibilities of successfully placing the species on other than very local markets.

During the latter part of July, 1918, after securing a permit from the State Fish and Game Commission, the writer made a shipment of the razor clam, *Siliqua patula*, from the Clatsop County beach to Netarts Bay for the purpose of transplanting the same on the ocean beaches in that locality. The clams were carefully packed and iced in Seaside and transported by express to Tillamook City and from there to Netarts by stage. The clams were out of salt water for a period of about 30 hours and reached Netarts in good condition. They were immediately planted on a selected beach south of the outlet of Netarts Bay. Favorable reports came to the writer during the summer of 1919 relative to the appearance of razor clams on this beach.

Tests of the keeping qualities of *Mytilus edulis* and *Mytilus californianus* were conducted in the Netarts region. Neither of these species is a good keeper after having been removed from the salt water. The larger species may be kept alive for two or three days on ice, but neither is to be recommended as proper food for a longer period than 24 hours after having been taken from the rocks. The temperature with which they are surrounded will largely determine their keeping qualities.

Although this region is abundantly supplied with the larger sea mussel there is scarcely a probability of its soon becoming a common article of diet. Even if it were fully appreciated as food by the public, its inaccessibility would be a handicap to its possible market value. These sea mussels are used locally to some extent and the writer can bear testimony that when rightly prepared they are very palatable.

Much work looking toward the determination of the spawning period of *Saxidomus giganteus* was done while the author was in this region and later with clams shipped to Eugene. This spawning period was not positively ascertained, the gonads appearing about equally developed in March, June, and November. More investiga-

tion is necessary to determine with certainty the spawning season or seasons of this species.

The western oyster has existed in Netarts Bay for many years. Its productivity here, however, has never been large. In 1918 the supply was insufficient for local demands, and few, if any, oysters reached outside markets from this source. The statutes of the State define the limits of the natural and artificial beds of oysters in Netarts Bay and the regulations governing the same, as in case of the Yaquina River.[4]

Salt-water crabs are very plentiful in Netarts Bay in certain seasons of the year. The closed season, during which no crabs may be shipped out of the county or canned, has been fixed by statute from July 1 to September 30 of each year.[5] During the open season shipments of crabs are frequently made to outside markets and many are consumed locally.

The Tillamook region comprises Tillamook Bay to the north and east of Netarts Bay. The most important clams of Tillamook Bay are *Mya arenaria*, which is inferior in size and quantity to the same species in the Siuslaw River, and *Cardium corbis*, which in 1917 was very plentiful opposite the town of Garabaldi on the north side of the bay. The species grows to a very large size here, and during 1917 was the chief, although not the exclusive, bivalve used by the clam cannery of Tillamook City. This clam cannery, the only one on the Oregon coast, is owned and operated by E. J. Bowers. The chief product of the cannery is minced clams put up in one-half and one-pound cans. The output in a normal year is from 500 to 1,000 cases, each of forty-eight 1-pound tins. A ready sale is found for this minced clam product and it is widely distributed. The activity of the cannery, however, is not constant, owing to the fact that the supply of clams is very irregular, it being difficult to get fishermen to devote their time to clam digging when more money can be made in the salmon boats. During the year of 1917 the cannery did a very good business, but its activity was not so great during the following year for the reason previously stated.

THE CLATSOP COUNTY REGION.

The northwestern coast of Oregon from Tillamook Head to the Columbia River consists of a long stretch of sand beach nearly 14 miles in length. It is, however, only the southern extremity of this beach that is of interest in connection with the shellfish resources of the Northwest. The beaches opposite the towns of Seaside and Gearheart, just north of Tillamook Head, are the principal sources of the razor clam, *Siliqua patula*, in Oregon.

As mentioned in a previous section, the razor clam during a period from 1913 to 1916 became almost totally extinct along the shores of this State south of Tillamook Head. But whatever may have been the cause or causes of the depletion to the south, no appreciable effect was made upon the species north of this headland.

Of all the species of clams on the Oregon coast the razor clam is the only one protected by law, and this protection is made applicable

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[4] Oregon Fish and Game Laws, 1919–20, sec. 194, p. 78.
[5] Oregon Fish and Game Laws, 1919–20, sec. 198, p. 79.

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to Clatsop County only. A closed season is here established, making it unlawful for one to take the razor clam for sale or canning or shipment out of the county during the period from June 20 to September 20 of each year. Anyone may take the clams, however, without limit at all times for his own use.[6]

The closed season does not prevent a considerable amount of wanton destruction and waste of the razor clams during the summer months. Seaside and Gearheart are summer resorts with a greatly increased population during the months of July and August. Hundreds of inexperienced clam diggers attempt to dig razor clams often for the novelty of it alone, and in so doing destroy a great many young or half-grown clams, or crush the shells of adults in trying to remove them from the sand and throw them away.

Siliqua patula is considered by many to be the best edible clam in the Northwest. It brings the highest market price, usually selling for 25 cents per dozen. During the open season it is almost constantly on the Portland markets, shipped either from the Clatsop County beaches or from the Washington shore north of the Columbia River. In former years this clam was to be found in the markets of many of the cities of northwestern Oregon, but in 1919 the species was rarely handled outside of Portland and Astoria. These cities are in direct connection by rail and boat with the sources of supply and markets here find a ready sale for all razor clams they can secure.

Siliqua patula is not a long-lived clam after having been removed from salt water. It is good for the Portland markets which can be reached from Seaside in five hours by express, but the clams would hardly be good for food after the second day even though thoroughly iced. The razor clam is a food to be consumed or canned locally, or marketed within a short distance from the source of its production.

That the razor clam spawns on the Clatsop County beach during the summer, from the latter part of June through July, has, it is believed, been well established. At no other season of the year was the writer able to discover the gonads in a mature condition. During the first and second weeks in September large numbers of young, ranging from 10 to 25 millimeters in length, may be found just beneath the surface of the sand. These are, without doubt, results of the spawning of the species during the previous June or July. The author was not able to determine the rate of growth of this species throughout an entire year or the age of the larger individuals. Owing to the fact that the razor clam travels about through the sand, more or less, it is impractical to attempt to judge the rate of growth by means of artificial plantings on the open beaches.

Shipments of razor clams for the purpose of restocking depleted beaches were made during the summer of 1918 from Seaside beach to Netarts Bay, as mentioned under the discussion of the preceding region, and also to Cannon Beach, immediately south of Tillamook Head. There is reason to believe that both of these plantings were successful.

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[6] Oregon Fish and Game Laws, 1919–20, sec. 143, p. 62.

THE SOUTHWESTERN WASHINGTON REGION.

This section of the survey included the ocean beaches north of the mouth of the Columbia River to the outlet of Willapa Bay, the latter body of water, and brief investigations of the resources of sections of Puget Sound in the vicinity of Olympia, Wash.

In 1917 the output of minced clams of the canneries of Nahcotta, a town on the west shore of Willapa Bay, was very limited, the reason ascribed for the unusual inactivities of the canneries being an apparent depletion of the supply. During the following year, however, the clams were much more plentiful and the output of the canned product was greatly enhanced. The Washington beaches are a source of supply of fresh clams for the markets of Portland and other cities of the Northwest.

Willapa Bay is one of the chief centers of distribution of the eastern oyster in the Northwest. Artificial plantations of considerable area have become established in these waters. The "tokepoint" oyster is a familiar one in the markets of many cities of the Northwest.

It is customary for the oyster companies to ship young eastern oysters from the Atlantic seacoast in carload lots, plant them for periods of from two to four years, and then place them on the markets.

That there are prospects of inducing the eastern oyster to propagate on the west coast is indicated by the spawning of the species in certain localities in Willapa Bay during the season of 1917. Heretofore it was the general belief that the temperature of the waters of the Pacific coast was too cold to permit of the propagation of the eastern species.

The Long Island Oyster Co., with headquarters at South Bend, Wash., reported to the writer in 1918 that it was its belief that the degree of temperature of the water was not the deciding factor, but that a uniformity of temperature must be maintained to induce spawning. This belief was based upon careful observations of the spawning of the eastern species by the above company on certain of their plantations in Willapa Bay during the previous season.

The broad mud flats of the western shore of Willapa Bay maintain a good supply of the eastern mud clam, *Mya arenaria*, but this species is little used here as food except by a very few local consumers.

The gravel beds of the southern arms of Puget Sound supply the markets of many cities of Washington, of Portland, Oreg., and of many of the upper Willamette Valley towns with the "little-neck clam," *Paphya staminea.* Paphya is one of the best of shippers among the shellfish of the Northwest, having a hard shell which closes tightly when the clam is removed from the water.

Tests with *Paphya staminea* from this region and others in the course of the investigations indicate that the clam may be kept in an edible condition for at least a week after having been taken if it is well iced. It will remain good for several days without ice if kept in a cool place.

The oyster industry of southern Puget Sound waters was greatly handicapped by excessively cold weather during the winter of 1915, which froze large quantities of the oysters. The output from this region was curtailed during the following seasons while the beds were being restocked. This reduction of Puget Sound oysters increased the price of western oysters grown in the Yaquina River in Oregon, where no such calamity occurred. The latter region, however, could not supply the demand, and there was a noticeable scarcity of oysters throughout the Northwest. Three or four years were devoted by the Puget Sound growers to restocking their beds, but by the season of 1919 almost normal conditions prevailed in the oyster industry of the Northwest.

Pectens have not been taken from the open ocean in large amounts off the northwest coast. The writer has, however, seen quantities of them dredged in the San Juan Archipelago about 100 miles north of Seattle, Wash. Several species of these mollusks have been taken here while dredging was being done for other material. Enough have been taken, however, to indicate that they are well distributed in these waters and present in considerable numbers.

The author has been informed that pectens have occasionally been taken from the ocean off Yaquina Bay and have appeared on the Newport market. There seems, however, little attempt on the part of fishermen to make surveys along the northwest coast for pectens, and the boats are usually without proper dredges or trawls with which to take these mollusks.

SHELLFISH RESOURCES OF MINOR IMPORTANCE.

In addition to the regions discussed above, which represent the chief producing centers of shellfish in the territory surveyed, there are a number of other localities of minor importance which should be mentioned in order to make this report complete. They are, for the most part, in isolated regions and in thinly populated districts having inconvenient means of communication with outside points.

Shellfish, although frequently occurring in large quantities in these isolated regions, have, at present, little economic value except as they may supply a very limited local demand for sea-food products; or, the shellfish may be species not yet generally recognized as proper human food. To this latter group belong the mussels.

On the Oregon coast, among regions of minor importance, the following may be mentioned:

CANNON BEACH.

This locality, immediately south of Tillamook Head, at one time supported large numbers of *Siliqua patula*, the razor clam, but in 1918 the author was not able to find a single one throughout the entire length of the beach. *Mytilus edulis* and *Mytilus californianus* are common forms on the rocks standing out from the shore, but little importance is attached to them in this locality.

During August, 1918, plantings of the razor clam were made on this beach from a shipment from Seaside.

NESTUGGA BAY.

In Nestugga Bay, at the mouth of the Nestugga River, are to be found small areas well stocked with *Mya arenaria.* The species here is inferior in size to that of the Siuslaw River and plays little part in the food economy of the locality. Some slight use is made of the clam by the inhabitants of Pacific City, a small village near the mouth of the river. This local demand is larger during the summer months, when the population is increased by tourists, but this shellfish center is of slight importance, due to its isolation.

SILETZ BAY.

Siletz Bay, in Lincoln County, Oreg., is at the mouth of the river bearing that name. *Mya arenaria* and *Schizothaerus nuttalli* are to be found in some abundance on the mud flats of this bay, but, being in a very inaccessible region, little use is made of these shellfish except occasionally by the inhabitants of Taft, a small settlement on the bay.

About 10 miles north of Siletz Bay is a stretch of sand beach several miles in length, paralleled by a fringing chain of large rocks, now disconnected with the shore, but easily reached from it during low tide. Here covering the surface of the rocks are immense quantities of the large sea mussel, *Mytilus californianus.* In the region surveyed the productivity of this locality is rivaled only by that of the Netarts Bay region, mentioned above. Should a market be provided for this shellfish, there would still remain the difficulty of transporting it from a region so isolated and inaccessible as this one north of Siletz Bay.

ALSEA BAY.

This body of water, 14 miles south of Yaquina Bay, supports a good supply of *Schizothaerus nuttalli*, the "great blue clam." The demand for this clam here is wholly local, small quantities being used by the inhabitants of the town of Waldport and by the few ranchers in the immediate region.

WINCHESTER BAY.

Winchester Bay, at the mouth of the Umpqua River in Douglas County, Oreg., may be mentioned as another center well supplied with the "great blue clam," *Schizothaerus nuttalli.* A few tourists spend some time at this place during the summer, but the region about the bay is very sparsely settled. The chief means of reaching Winchester Bay is by motor boat from points farther up the river. Due to the isolation of the district and the inconvenient means of communication little value may be attached to this shellfish source.

THE BANDON BEACH.

From the mouth of the Coquille River southward the chief shellfish are the sea mussels which are very abundant opposite the town

of Bandon, at the mouth of the river, and elsewhere on rocky points and headlands.

Many of the sections of this portion of the coast are isolated and sparsely settled and, although the mussels are used to some extent locally, little economic value can be ascribed to the molluscan shellfish on the Oregon coast south of Coos Bay.

SUMMARY AND CONCLUSIONS.

1. Certain regions of the northwest coast are abundantly stocked with shellfish, some species of which have been widely recognized as excellent human food. Others, however, such as the sea mussels, have not yet gained that same recognition, and there remains to be devised in the future some plan or method to convert this vast quantity of sea product into economic usefulness.

2. The isolation of certain regions producing shellfish, especially in the coastal zone of the State of Oregon, and the lack of highways paralleling the coast or other means of transportation rendering sources of shellfish accessible has, in some places, proved a handicap and in others a complete prohibition against the general use of these sea-food products.

3. Demonstration has proved that certain species of shellfish, however excellent food they may be when prepared immediately after having been taken from the salt water, lack lasting qualities and, therefore, are not adaptable to markets at any great distance from the source of their supply.

4. Other species as *Mya arenaria*, *Saxidomus giganteus*, and *Paphya staminea* have lasting qualities and may be kept, under proper conditions, for many days in a fresh condition and marketed several hundred miles from the coast with perfect safety to the consumer.

5. Species not adaptable, in a fresh condition, to markets other than local should be prepared and consumed as soon as possible after they have been taken from the salt water, or they should be preserved by canning, pickling, or other methods insuring the destruction of harmful bacteria and at the same time retaining something of the qualities of the shellfish.

6. In many of the regions of the Northwest where shellfish are abundant the people are found to be very generally appreciative of the bivalves as food, especially if markets or centers of distribution have been established where the product can be obtained without too much effort.

7. A certain amount of indifference, sometimes amounting to antagonism, against the use of shellfish as food, was encountered in some localities. This was met as tactfully as possible and by conversation, lecture, and sane publicity the aversion to these sea products was in some measure dispelled.

8. The apparent depletion of an excellent food mollusk, *Saxidomus giganteus*, is taking place in Netarts Bay. It may be advisable to restrict or prohibit entirelv the taking of this species for a number of years.

9. After the almost total disappearance of the razor clam from the Oregon beaches south of Tillamook Head, it was gratifying in 1919 to learn of and to observe its reappearance in a number of

FIG. 3.—VIEW OF CLAM BEDS OF SIUSLAW RIVER, ON NORTH SIDE OF CHANNEL, LOOKING TOWARD FLORENCE.

Mya arenaria is abundant here. The beds are very accessible and the clams, in size and quality, are not surpassed by any of the same species in the Northwest.

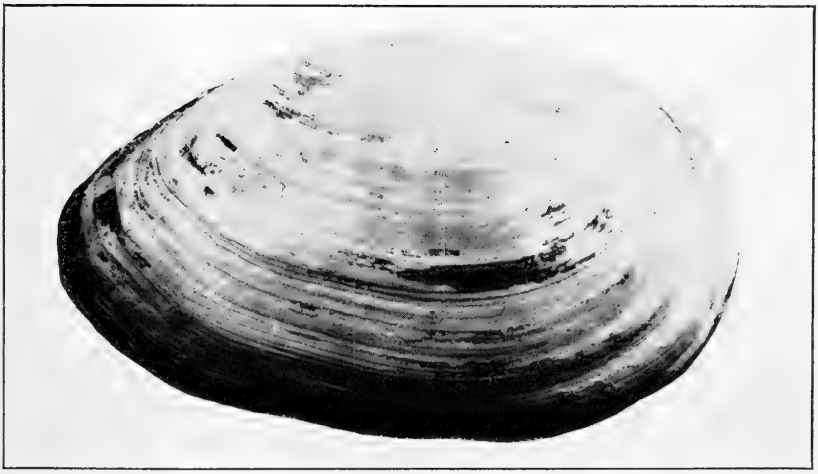


FIG. 4.—SHELL OF *Mya arenaria*, TWO-THIRDS NATURAL SIZE.

Mya is one of the best clams of the Northwest both for local consumption and for shipping. See discussion under The Siuslaw Region, beginning on page 5.

FIG. 5.—MUD FLATS OF NORTH SIDE OF YAQUINA RIVER, LOOKING TOWARD YAQUINA.

Here is a large supply of *Schizothaerus nuttalli.* The beds are accessible from Newport, and the clams are easily taken as they are not deeply imbedded in the mud. *Cardium corbis, Paphya staminea,* and *Macoma nasuta* are also found here. See discussion under The Yaquina Region, beginning on page 8.

FIG. 6.—SHELL OF *Schizothaerus nuttalli*, THE "GREAT BLUE CLAM," TWO-THIRDS NATURAL SIZE.

This species is well distributed along the Northwest coast and is used as food locally to a greater or less extent wherever it occurs.

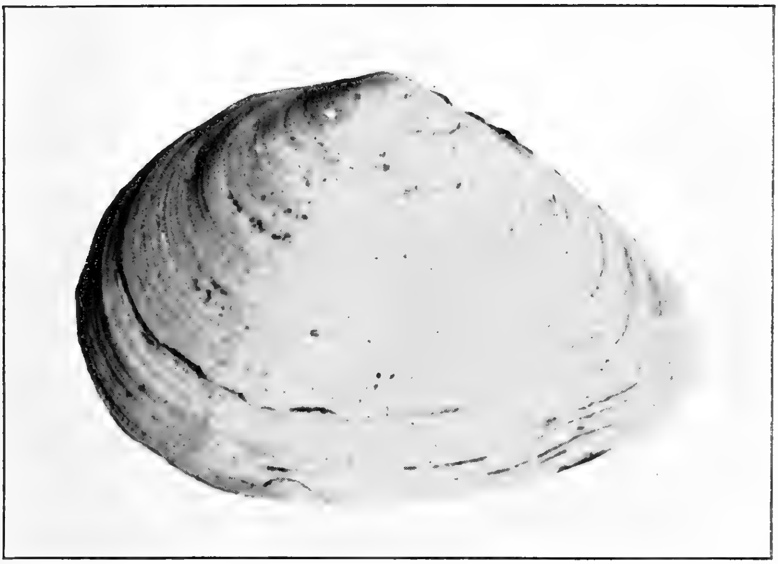


FIG. 7.—SHELL OF *Macoma nasuta*, NATURAL SIZE.

It is called the "oyster clam" at Yaquina, where it is used as food to a slight extent. The species was common on the north side of the bay in 1917. The photograph is of a shell from Winchester Bay and is somewhat larger than the average in Yaquina Bay.

FIG. 8.—SHELL OF *Paphya staminea*, THE "LITTLE NECK CLAM," NATURAL SIZE, FROM YAQUINA BAY.

The species occurs in almost all of the bays of the Northwest. It is one of the best market clams.

FIG. 9.—SHELL OF *Pholadidea penita*, A ROCK BORER, NATURAL SIZE.

The species is characteristic of Nye Beach, on the ocean side of Newport, where it is plentiful.

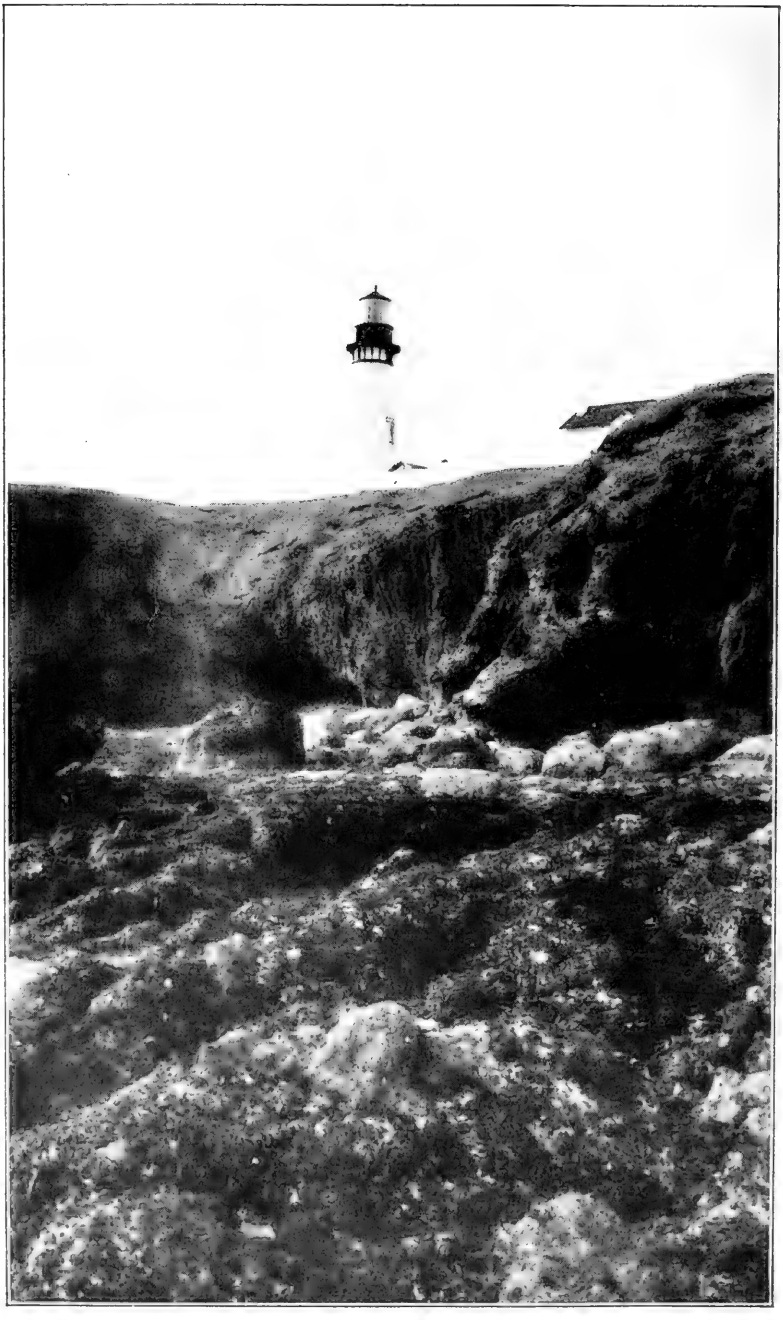


FIG. 10.—ROCKS ABOUT THE BASE OF YAQUINA HEAD, 4 MILES NORTH OF YAQUINA BAY.

These rocks are well covered with sea mussels, both *Mytilus edulis* and *Mytilus californianus* occurring here. Little use is made of them as food. See figure 13.

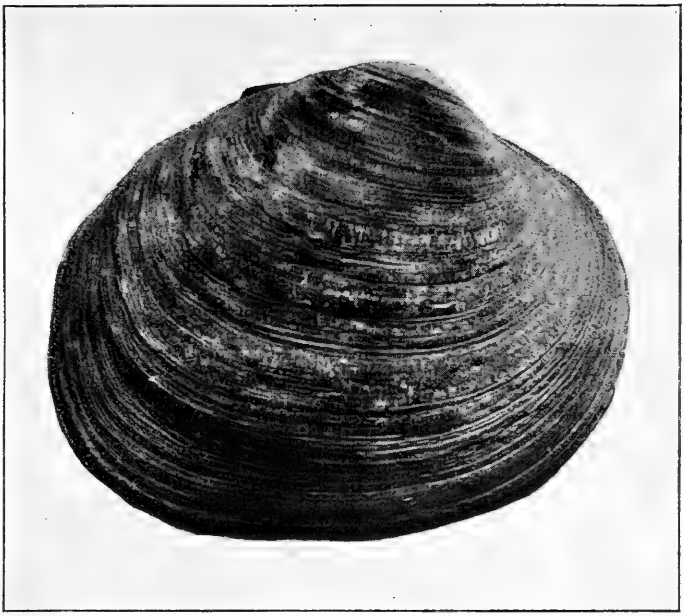


FIG. 11.—SHELL OF *Saxidomus giganteus*, TWO-THIRDS NATURAL SIZE.

This species is characteristic of Netarts Bay, but is not so abundant there as it was a few years ago. It is one of the best food clams of the Northwest and makes an excellent market clam as its shipping qualities are good. Its scarcity in Netarts Bay at the present time, however, precludes its shipment to outside markets. See discussion under Netarts and Tillamook Regions, beginning on page 12.

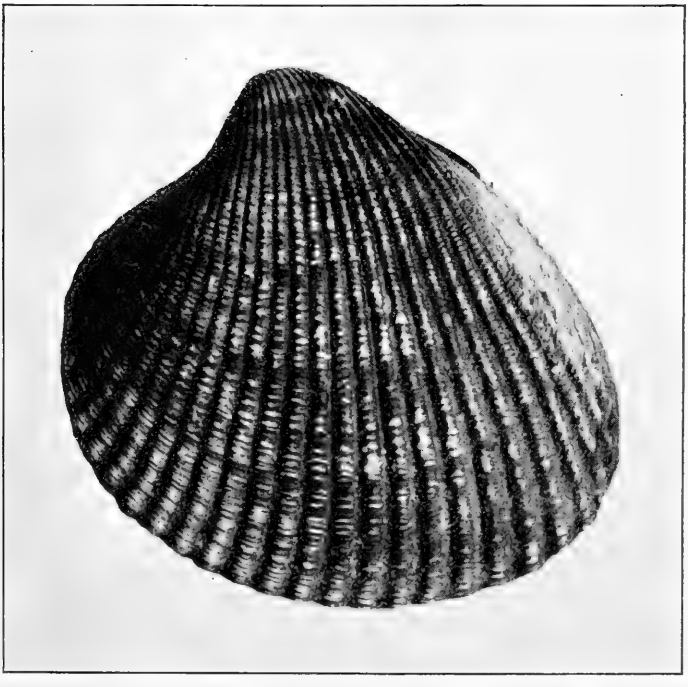


FIG. 12.—SHELL OF *Cardium corbis*, THE "COCKLE," TWO-THIRDS NATURAL SIZE.

This species is well distributed from Coos Bay northward along the Northwest coast, and is abundant in Tillamook Bay.

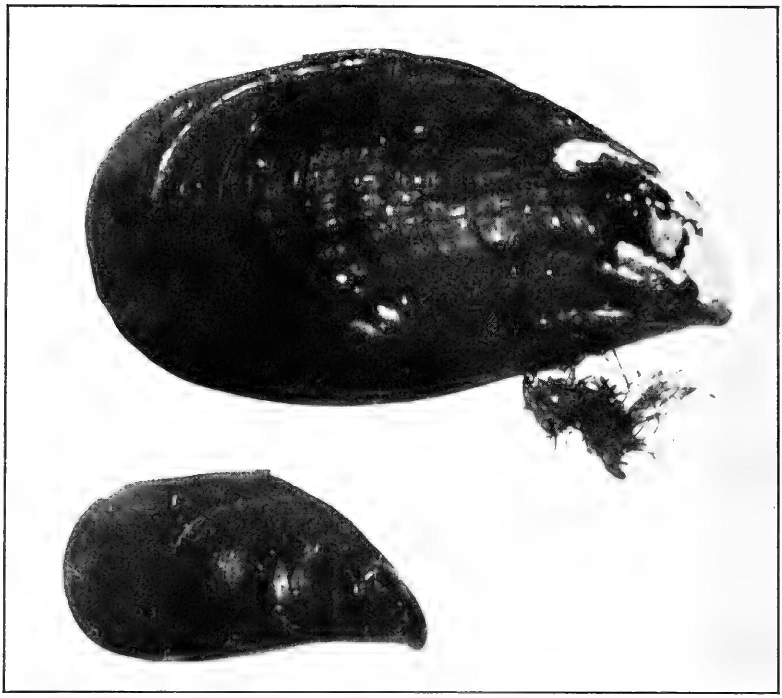


FIG. 13.—UPPER, *Mytilus californianus*, THE LARGE SEA MUSSEL; LOWER, *Mytilus edulis*, THE SMALLER SEA MUSSEL; EACH THREE-FOURTHS NATURAL SIZE.

Both species are very common along the Northwest coast.

FIG. 14.—PORTION OF SURFACE OF A ROCK NORTH OF NETARTS BAY COVERED WITH *Mytilus californianus*.

FIG. 15.—VIEW OF CLATSOP COUNTY BEACH OPPOSITE SEASIDE, OREG., LOOKING SOUTH TOWARD TILLAMOOK HEAD.

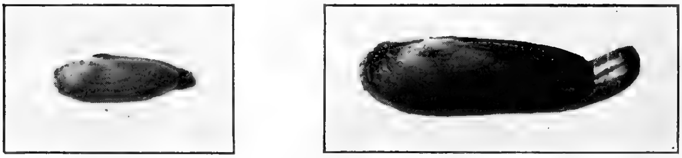
Although the razor clam, *Siliqua patula*, has almost disappeared elsewhere on the Oregon coast, it has maintained itself in abundance on this beach. See discussion under The Clatsop County Region, beginning on page 15.

FIG. 16.—ROCKY COAST AROUND TILLAMOOK HEAD, LOOKING SOUTH.

Sea mussels are typical shellfish of rugged headlands such as this.

FIG. 17.—CLATSOP COUNTY BEACH, LOOKING NORTH FROM SEASIDE AT LOW TIDE.

The sand heaps represent places from which razor clams have been taken. This is the center of the razor clam production in Oregon at the present time.



FIGS. 18 AND 19.—YOUNG RAZOR CLAMS, NATURAL SIZE.

These were taken on the Seaside beach during the first and second weeks in September. The species spawns on this beach in midsummer.

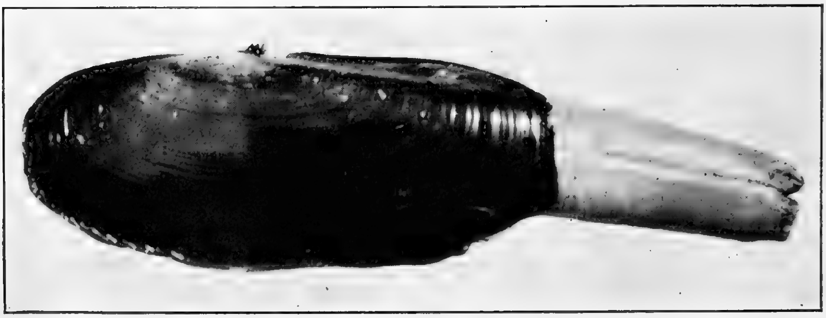


FIG. 20.—THE RAZOR CLAM, *Siliqua patula*, TWO-THIRDS NATURAL SIZE.

This species is considered one of the very best edible clams and is used as food extensively. The supply for the markets of the larger cities of the Northwest comes from Clatsop County, Oreg., and from the beaches of the Washington coast.

FIG. 21.—SHELL OF THE EASTERN OYSTER, *Ostrea virginiana*, TWO-THIRDS NATURAL SIZE.

This species is planted when young and grown to maturity in the waters of western Washington. The eastern oyster industry is not yet developed in Oregon. See discussion under The Southwestern Washington Region, beginning on page 17.

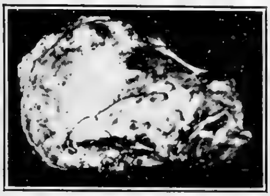


FIG. 22.—SHELL OF THE WESTERN OYSTER. *Ostrea lurida*, TWO-THIRDS NATURAL SIZE.

This species is grown in both Oregon and Washington. In Puget Sound the industry has become an extensive one.

FIG. 23.—SPAT OF THE WESTERN OYSTER COLLECTED ON THE SHELL OF *Paphya staminea*, TWO-THIRDS NATURAL SIZE.

The spat was collected during the season of 1917 and was about five months old.

FIG. 24.—SECTION OF SHORE LINE 10 MILES NORTH OF SILETZ BAY.

The rocks paralleling the coast are densely covered with the large sea mussel, *Mytilus californianus*. This region is an isolated one.

FIG. 25.—PORTION OF SURFACE OF ONE OF THE ROCKS IN FIGURE 24.

Masses of the large sea mussel are shown in the upper half of this picture.

localities on the coast of that State. A complete restoration of this important food mollusk is not impossible during the next few years. Successful transplantings of the razor clam from Clatsop County beaches to other points on the coast, made in 1918, were not wholly responsible for the reappearance of the species the following year, as it appeared on beaches other than those where plantings were made.

10. Information gained relative to the spawning seasons of certain food clams as *Mya arenaria*, *Siliqua patula*, *Schizothaerus nuttalli*, *Paphya staminea*, etc., may be valuable in the future should it be deemed wise to place restrictions upon the taking of the species.

11. Oyster culture has been an important industry in the Northwest for many years, especially in the waters of Puget Sound and Willapa Bay in Washington. In Oregon the industry, although of considerable importance, has never reached the proportions that it has north of the Columbia River. The success of recent plantings of the western oyster in Coos Bay gives promise of the development of this industry on a larger scale than heretofore in the State of Oregon.

12. Several species of pectens are known to exist in considerable quantities in certain parts of Puget Sound, namely, about San Juan Island. Whether or not species of pectens are sufficiently abundant off the northwest coast, other than in Puget Sound, to make them of commercial value has not yet been determined.

USE OF FISHES FOR CONTROL OF MOSQUITOES IN NORTHERN FRESH WATERS OF THE UNITED STATES.[1]

By J. Percy Moore, *University of Pennsylvania, Temporary Investigator, U. S. Bureau of Fisheries.*

CONTENTS.

INTRODUCTION.

At the outset of our participation in the World War a demand arose for the suppression of malaria and mosquitoes, especially with a view to improving the healthfulness of cantonments and increasing the efficiency of workers in war industries. The Bureau of Fisheries was early called upon to cooperate, and its correspondence of that period included many requests for advice on the employment of fishes as destroyers of mosquito larvæ, especially in waters to which the engineering solution of drainage could not be satisfactorily applied. In the South this phase of antimosquito work was better understood and the remedy rather extensively applied. The mosquito-eating habits of the top minnow (Gambusia) were well known and tested, and especially under the able direction of S. F. Hildebrand this little fish has been very successfully employed. In the North fishes have been little utilized hitherto in the actual work of combating mosquitoes in fresh waters, though the killifishes (Fundulus) are well known as destroyers of the salt-marsh species.

The writer having volunteered for war service was, therefore, in the spring of 1918 assigned the problem of determining what species of fishes in northern fresh waters were mosquito destroyers and what the conditions of their utilization were. At his request the

[1] Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 923.

investigation was broadened to cover the whole subject of mosquito control through natural biological agencies as distinguished from mechanical measures which aim at the complete elimination of breeding areas chiefly through permanent drainage and filling.

During the three seasons of 1918, 1919, and 1920 as much time was given to the investigation as other duties would permit. The work as planned was broadly observational and experimental and covered a territory providing as great a variety of conditions as possible. The principal experimental work was done on ponds, creeks, and marshes in Philadelphia and Delaware Counties, Pa., and in Palisades Interstate Park in New York. Observations were made and minor experiments were conducted at other points in these and the adjoining States of New Jersey, Delaware, and Maryland. Salt and brackish marshes were studied principally in Cape May County, N. J., and on the Eastern Shore of Maryland; fresh-water tidal marshes, on the Delaware River and its tributary creeks in Pennsylvania and New Jersey; and upland waters, consisting of a great variety of swamps, swales, ponds, dams, lakes, and streams, especially in Philadelphia, Delaware, Chester, Montgomery, Bucks, and Monroe Counties, Pa., Gloucester, Mercer, Essex, and Morris Counties, N. J., and Orange and Rockland Counties, N. Y.

So many persons were helpful in various ways that it is impracticable to name all, but special mention must be made of Mr. and Mrs. George F. Yerger, of Mound, La.; W. V. Becker, in charge of the antimosquito campaign in the Hog Island region; James E. Brooks, engineer of the Essex County (N. J.) Mosquito Extermination Commission; Prof. C. C. Adams, of the New York State College of Forestry; and Maj. William A. Welch, chief engineer and general manager, and Edward F. Brown, superintendent of Camp Activities, both of the Palisades Interstate Park staff.

SOME ASPECTS OF THE MOSQUITO PROBLEM.

In the several decades that have elapsed since Ross, Grassi, Gorgas, and other pioneers worked out the methods of combating the mosquito hosts of the malarial, yellow fever, and filariasis parasites, which were later applied to mosquitoes in general, a considerable change has become noticeable in the expert's attitude toward the problem. While engineers now work with a confidence and precision born of successful experience, we nevertheless hear much less of mosquito extermination than in the early days of enthusiasm. The mosquito problem has grown in magnitude and complexity as knowledge has widened and deepened. As the larger difficulties have been overcome the smaller ones have multiplied. Mosquito extermination has become a futile ideal except for limited metropolitan or other comparatively circumscribed and wealthy areas, where large sums of money for permanent construction and drainage are available. Some of the worst breeding places may be eradicated anywhere, but to completely abolish the moderate breeding which takes place in natural waters over the country generally is beyond our practical resources. It is doubtful if complete mosquito extermination, even were it really desirable, could be effected otherwise than by the elimination of all standing water, and a waterless world would hardly be fit for human habitation.

The larger aim, therefore, is shifting from extermination to mitigation and control, especially as it has been found necessary to extend the operations farther from the densely populated centers to suburban and rural districts where sparse population and limited funds forbid expensive methods. This is notably the case in the South, where boards of health and sanitary engineers are grappling with the stupendous malarial problem and are seeking methods of mosquito control less expensive and often more desirable than complete drainage. Judging from the experience of the past two or three years one such means has been found in the use of the top minnow. To determine if any similar means capable of wide and general application at small expense exists in the fresh waters of the North this investigation was begun.

It has long been known that many species of small fishes and predacious insects inhabiting these waters will eat mosquitoes, but little has been done to determine the conditions under which they may be used effectively or the technique of their application to mosquito control. In the absence of precise biological data the development of this technique has made little progress. While many mosquito fighters appreciate the value of fishes, others hold one of three conflicting views—either they are unconvinced that fishes have a place in their particular programs, or they think that almost any species of small fish once introduced into mosquito-infested waters should automatically destroy the larvæ, or they complain that although fishes are present they do not eat the mosquitoes living in the same waters. None of these shows a full understanding of the relation that fishes bear to the associated mosquitoes or of the conditions under which they may be effectively utilized in their control. It is the biologist's duty to furnish these data.

BIOLOGICAL FACTORS IN THE NATURAL CONTROL OF MOSQUITOES.

Without destroying or greatly altering the habitats in which they live or without killing them, together with associated organisms, by means of poisons or other purely artificial means, how may the conditions under which mosquitoes live be so modified as to reduce their numbers to a minimum? Thus stated, the problem obviously becomes an ecological one. It is a problem of the relation of mosquitoes to their immediate physical environment or habitat and to their living environment or associated biota.

The theory of the repression and control of mosquitoes in the interest of human health and comfort may be stated as follows: From the point of view of the biologist both man and the mosquito are successful types which in their spread over the earth have come into conflict. Human dominance requires no discussion. That of the mosquito is evidenced particularly by four facts: First, their nearly cosmopolitan distribution; second, their great diversity in species and genera; third, their great range of adaptability to nearly every possible variety of still-water habitat and the complexity and perfection of their specific adaptations to special conditions; and, fourth, their great fecundity and almost inconceivable abundance in places widely separated geographically and of great climatic and physical variety. Anyone who doubts this should read such a book as Howard, Dyar, and Knab's Monograph (1912–1917) or visit the Arctic tundra, the

undrained salt marshes of New Jersey, the tropical swamps of Central America, or the plains of New Zealand.

As is always the case with widely distributed and abundant animals, mosquitoes have acquired a host of enemies which prey upon them at all periods of their lives. They are also afflicted with parasites, both animal and plant. Furthermore, many species of mosquitoes in their immature stages must compete for food with a variety of animals, and the food supply of the female imagos is a more or less precarious one. Also, the very perfection and complexity of their specialized adaptations renders their adjustments to unstable environmental conditions delicate and easily upset.

Nevertheless, with all the great array of dangers with which they are beset and the numberless enemies which press upon them from all sides and seek to devour them in water and in air as eggs, larvæ, pupæ, and imagos, mosquitoes are only too obviously abundant and nearly omnipresent. How does this happen? Why do not their enemies and competitors overcome them? Clearly it is because during the long period of their evolution, along with their associated biota, mosquitoes have acquired a degree of fecundity sufficient to furnish not only the toll demanded by their raveners but a surviving surplus to maintain the several species at their normal but changeable numerical balance. The fact that mosquitoes and animals which are known to prey upon them are found in association is a necessary consequence of this relation and does not mean either that the latter will in time exterminate the former or that they are exerting no checking influence upon them, both of which opposite assumptions are sometimes made. It means only that the index of fecundity of each is such as to maintain the necessary balanced relation between predator and prey, so that the racial survival of both is secured. Were this not true of mosquitoes they must have ceased to exist, and doubtless species have become extinct for this very reason. In the interaction of the multitudinous checks and balances that operate among the elements of an ecological complex there is always a large reserve or factor of safety (residing mainly in reproductive capacity) as there is in all compensatory regulative processes in nature. These relations are seldom simple and direct and may seldom be assumed. Many examples of this might be cited. All biologists understand the significance of these interrelations called the balance of nature, but persons without biological training often misunderstand their meaning.

If, therefore, mosquitoes occur in such numbers as to prove a pest in any locality, they may be attacked by so modifying an existing relation or introducing a new condition as to effect changes beyond their range of adaptability or regulation, thereby establishing a higher rate of mortality and reducing or overcoming their factor of safety in reproduction. The engineer works chiefly by modifying the physical environment. The knowledge that mosquitoes pass the immature stages of their lives in standing water enables him to greatly restrict breeding by destroying such bodies of water. The knowledge that most species of mosquito larvæ and pupæ respire chiefly by means of tracheæ, the air in which must be renewed at the surface at frequent intervals, has suggested the second most gen-

eral means of attack. By spreading a thin film of oil on the surface of the water the opening of the breathing tube is clogged and the mosquito, either repelled by or unable to break through the film, consequently quickly succumbs to oxygen starvation.

These methods and others that operate by changing the physical environment have the disadvantage for universal application that they are seldom confined in their effects to the mosquito alone. The complete destruction of pools or swamps, of course, destroys along with the young mosquitoes all of the associated life dependent upon aquatic conditions. The effects of the oil film are equally deleterious to other insects having habits similar to the mosquito larvæ, to the surface plankton, and to many delicate, partly submerged plants and even to some fishes. Other larvicides in common use are also not specific in their action and may be poisonous to other organisms than mosquitoes. A larvicide that will kill the young of mosquitoes only is a great desideratum.

Quite aside from the natural desire of the biologist to preserve rather than to destroy life there are important reasons, chiefly piscicultural, sanitary, or esthetic, why aquatic life should be disturbed as little as possible. With the progressive contamination of our larger streams the waters of swamps, ponds, and brooks are becoming steadily more important as reservoirs from which must come certain of the purifying organisms upon which to a considerable degree the salubriousness of an area depends.

More directly apparent is the viewpoint of the fisheries. The very bodies of water in which mosquitoes breed so freely teem also with those minute forms of life which are the primary source of food supply of many insects, worms, and small fishes which again form the dietary of important food and game fishes. If the supply of the latter afforded by our fresh waters is to be increased, as is obviously desirable, or even to be maintained, these reservoirs of primary food supply must be safeguarded. The Bureau of Fisheries is greatly interested in this aspect of the problem as are the numerous State commissions and societies for the promotion of the inland fisheries and angling.

There are many other reasons why ponds and marsh areas should be conserved, as far as possible. The infant art of aquiculture will have much need of them when in the future it comes into its own. To wipe out absolutely entire ecological associations because a single member of a numerous community happens to offend is unscientific and clumsy and likely sooner or later to bring reprisals. Our successors will condemn us as we have condemned our predecessors for like delinquencies if we of to-day fail to conserve these resources.

Societies, like individuals and species, are possessed of a great capacity for self-regulation. They are plastic and within ascertainable limits will readily adjust themselves to disturbances in both the delicate internal balances existing between their component members and the external balances between the whole complex and its external environment. How to change the status of a single member of such a society clearly lies within the province of study of that branch of biology now generally called ecology, which is a modernized and scientific natural history characterized especially by

methods of relative precision. The solution of many existing aspects of the mosquito problem must be sought through the methods of ecology.

In applying these methods to an existing mosquito nuisance[2] the first step toward mitigation is to ascertain the species involved, whence they come, and the ecological associations to which they belong. When the latter come to be studied, it will probably be learned that a condition or conditions exist peculiarly favorable to the development and survival of the young stages of mosquitoes or, what amounts to the same thing, that are unfavorable to the action of natural repressive influences. Such may be the absence or paucity of enemies or their ineffectiveness through the existence of physical or physiological barriers. It may be that the productive breeding places are newly established water areas, into which the more important inhibitory elements of the association have not yet penetrated or where they have not yet reached their normal numbers. It may be that some specific change in the physical or organic environment has taken place which acts as a check to the multiplication of an important enemy but remains neutral to the mosquitoes; or it may be that a barrier has arisen which prevents these enemies, although present in sufficient numbers, from reaching the mosquitoes and which serves, therefore, as an added means of defense for the latter. It may be simply that food for the larvæ is unusually abundant and nutritious, and this again may arise from conditions of water, temperature, etc., favoring the growth of minute organisms; or it may be due to the absence or scarcity of animals which ordinarily compete for the same food supply. All of these and other conditions were met with in the course of this investigation.

When the factor or factors which (from the viewpoint of mosquito control) are at fault in any particular case have been ascertained, it remains to neutralize or remove it or them with as little disturbance of the remaining factors as is consistent with attaining the desired end of reduction of the mosquito element to a very subordinate place in the complex. In many cases it has been found easily possible to effect this without seriously jeopardizing any of the other living elements or other human interests. Looking upon the relationship as a struggle between the mosquitoes and their enemies and competitors and on man as a powerful ally of the latter, the general strategic policy should be whenever possible to weaken the defenses and protective adaptations of the mosquitoes and to strengthen the offensive of their enemies. The tactics suitable to particular conflicts readily follow.

The theory of natural control has been discussed at some length not because the writer considers that he has anything particularly novel to offer on the subject—for doubtless all biologists and certainly all biologists of ecological training view it from much the same standpoint—but because conversations with a number of persons engaged in antimosquito work have shown a prevalence of the so-called practical attitude of demanding quick results and a single purpose, which is the attitude that has stripped our country of its forests, lowered the fertility of much of our agricultural land, con-

[2] These principles have no application to small, artificial containers of water, temporary pools, waters badly polluted by sewage, reclaimed swamps, etc., which produce vast numbers of mosquitoes and which are best dealt with by mechanical or chemical means.

taminated our watercourses, squandered our coal, petroleum, and gas, jeopardized our fisheries, and exterminated much of our larger wild life, and which if persisted in may be expected in time to defeat its own end by expediting human self-destruction.

In view of the very extensive antimosquito operations now in progress or planned, has not the time arrived to ask if a too exclusive adherence to the one thought of killing mosquitoes without regard to the effect of the methods employed upon the associated forms of life may not lead to regrettable consequences? Should we not seek to substitute, where feasible, ecological methods of control for elimination of the habitat?

In beginning the investigation data were collected and observations made upon a wide range of aspects of the subject, and a number of promising leads were discovered. Some of these have been followed far enough to yield material of considerable significance. It very soon became apparent that the problems involved are so numerous and intricate that many workers and much time will be required for their solution. Precise data are required upon so many points that only thoroughgoing, systematic, and long-continued investigations will answer.[3]

For this reason and because of the somewhat insistent demands for advice of immediate applicability attention was early concentrated upon fishes as affording the most effective and most readily utilized of all enemies of mosquitoes, thus confirming the judgment of many previous workers in widely separated parts of the world, but chiefly in the Tropics. The small fishes of the general region of the Delaware Valley afforded an abundance of material. The body of this report is limited to the results of investigations on several of these fishes, concerning which fairly definite conclusions have been reached. It is hoped that the investigations of certain other species of fishes and of other elements as well may be continued to a point where the results will be worthy of presentation in future reports. It seems probable that the reason why fishes have so far proved more amenable to utilization is chiefly because their habits and needs are better known. Far more attention has been devoted to the culture of fishes than to almost any other group of aquatic animals. If we were as well acquainted with the conditions of multiplication and spread of some of the predacious insects, for example, they might prove equally efficacious.

METHODS AND RESULTS OF INVESTIGATIONS ON FISHES.

The methods of these investigations were at once simple, fairly thoroughgoing, and comprehensive. After a preliminary examination of many ponds, swamps, streams, etc., at diversified localities in eastern Pennsylvania and New Jersey, during the course of which collections of the fauna and flora and ecological data were made, a number of typical bodies of water, chiefly small ponds, illustrating as wide a range of natural and artificial conditions as possible, were selected for detailed study. Stations were then located on each selected body of water at points where mosquitoes were breeding and at others where

[3] Such an investigation of the anopheline mosquitoes has been in progress at Mound, La., under the joint auspices of the Bureaus of Entomology and Fisheries, conducted for the Bureau of Entomology by D. L. Van Dine and for the Bureau of Fisheries by R. L. Barney.

none were found. The aim was to visit each of these at weekly or fortnightly intervals, but this was found to be practicable in the case of the more accessible stations only, such as those near Philadelphia and Media and in Palisades Interstate Park during the summer of 1919. The outlying stations were examined at longer and more irregular intervals.

Usually on each visit collections of fishes and other organisms were made with minnow seine, dip net, and by hand. So far as possible these were determined and recorded along with other ecological and physical data. Samples of the fishes taken were dropped immediately into 4 per cent formaldehyde to stop digestion and preserve the stomach contents for laboratory study. The density of mosquito breeding was determined by taking a number of samples of water (usually 10 at each point) in a small dipper. These were made as uniformly as possible of 3 to 4 fluid ounces. The number of mosquito larvæ, pupæ, and egg boats in each were counted and recorded and samples preserved for identification. While this does not give an accurate determination of the number of mosquitoes present it does give a fair basis for comparing the rate of breeding at different stations or at the same station on different days or under changed conditions. If adult mosquitoes were flying, samples of these also were preserved. This procedure was repeated at each station as often and as thoroughly as circumstances would permit and comparisons made between the fishes taken and the contents of their stomachs at mosquito-breeding and nonbreeding stations.

Numerous experiments were tried by modifying conditions in such manner that fishes were admitted to places from which they had been absent previously or, on the contrary, were debarred from places to which they had had free access. In general, comparison being made between stations in the same pond, the former were mosquito-breeding areas, the latter mosquito-free or nearly so.[4] These two sets of experiments served as reciprocal checks on each other and on the natural conditions remaining.

Admission of the fishes was effected by cutting or otherwise removing vegetation, removing stranded logs or débris, taking out rocks, cutting channels through bars or banks, etc., thus giving them natural access to new waters. In some cases actual transplantation of certain species to small ponds or detached pools was made on a small scale.

In order to bar fishes from a closed area, an opposite procedure was adopted. Most frequently wire screen was used for this purpose, and while there was no uniform size or form of inclosure a standard pen used in a number of cases measured 8 by 4 feet, divided into two parts each 4 by 4 feet, one being made of one-half inch or three-eighths inch cellar window screen, the other of wire mosquito screen, supported on a light wooden frame and held by stakes driven into the bottom. The fine screen stopped all fishes, even the smallest fry; the coarser one permitted the passage of minnows up to about 2 inches long and sunfishes up to $1\frac{1}{4}$ inches

[4] In no case was a body of water selected for experiment in which mosquito breeding had not been detected at some point or points within or in immediate proximity thereto, as in a communicating pool or bordering marsh. A number of bodies of water apparently suitable for breeding purposes were found from which mosquito larvæ were nearly or quite absent through the operation of causes other than the presence of fishes. These may be discussed at another time.

long. In many cases instead of pens a screen was stretched between two rocks projecting from the shore, or a stranded log was similarly utilized. In other cases little dams were built of driftwood, stones, brush, or whatever happened to be at hand and made tight with mud or turf. Sometimes holes were dug close to the side of a pond but separated from it by a narrow strip of the bank and allowed to fill with water. In general, the purpose was to accomplish the result with as little change in the existing conditions as possible, and one of the great merits of the work in Palisades Park is that an abundance of perfectly natural checks both ways were always at hand. Experiments were also made in introducing mosquito larvæ to fishes free in ponds or confined in pens, tanks, rain barrels, and aquaria, but little value is attached to these as bearing on the main problem of natural mosquito control.

Mosquito counts and other observations and collections similar to those already mentioned were made periodically both within and without the experimental areas. Comparison of the stomach contents of fishes proved especially interesting. In the original notes the stomach contents of each individual are recorded separately, and the different objects are entered both by numbers and as estimates of bulk in terms of percentages of the whole. Owing to lack of time specific determinations were seldom made except of mosquitoes and forms already familiar. In most cases genera were determined, but frequently the records give only families or even larger groups. This seemed sufficient, as the object was not to determine complete and exact dietaries but only whether the fishes were eating stages of mosquitoes and how the presence of other food might influence their use of mosquitoes. It was noticeable that mosquito remains were found more frequently in later than in earlier examinations. Probably this is due, in part at least, to an increasing familiarity with the minuter parts of the larvæ and pupæ, which were more often detected as the eye became better trained. Any error in the frequency of recording mosquitoes is of omission rather than otherwise. They are easily overlooked.

Of all the experiments made during the three seasons the most conclusive were those made in Palisades Park. In the vicinity of Philadelphia much annoyance and delay was caused by the depredations of mischievous boys and vandals, who constantly meddled with or destroyed the control pens and inclosures. Many experiments had to be discarded for this reason, and in some localities, as along Darby Creek, it became necessary to abandon work altogether. The excessive rainfall during the summer of 1919 also worked havoc with some experiments by causing streams and ponds to overflow the barriers. Notwithstanding these mishaps and limitations, a considerable body of sufficiently definite results concerning several species has been accumulated.

In reporting these results it seems best to select a few typical observations and experiments for somewhat detailed description as affecting particular species rather than to deal with all in a summary way. Other cases would merely add cumulative evidence. In reporting the stomach contents, also, some duplicate lots as well as some nonsignificant ones have been omitted from the tables, and in order to save space and make the facts clearer the data have been

condensed by grouping the stomachs in lots and recording the contents under comprehensive taxonomic groups. The percentages given were determined volumetrically by means of a short section of a graduated burette tube or, when the amounts were very small, on a plankton counting slide. However, owing to the usually fragmented condition of the remains and to the difficulty of completely assorting them and of separating the mucous and other foreign matter, they have no accurate quantitative value. In column 6 of the tables the first numeral indicates the number of stomachs in which mosquitoes were detected; the second, the total number of mosquitoes counted. When all of these data are brought together and compared, they present a significant and in some cases a conclusive body of direct and circumstantial evidence.

During the course of the investigation observations were made upon 29 species of fishes belonging to 9 families. Some of these have only an indirect or casual relation to the mosquito problem, others a very direct and important relation. In the case of some of the larger species the young only were studied, the habits of the adults being such as to remove them from the category of mosquito destroyers. Most definite conclusions were reached concerning the 9 species which receive special consideration in the following pages, viz, roach or golden shiner, goldfish, mud minnow, common killifish, translucent killifish, top minnow, blue-spotted sunfish, long-eared sunfish, and common sunfish.

ROACH OR GOLDEN SHINER (Abramis crysoleucas).

This species, with its subspecies *bosci*, is distributed over practically the entire United States east of the Rocky Mountains and is nearly everywhere abundant. In the region of these investigations, covering roughly a considerable part of the Delaware River and a portion of the lower Hudson River drainages, it is ubiquitous and found in waters of nearly all kinds—in the larger creeks and rivers, both tidal and upland, in the pools of small rivulets, in natural lakes and ponds of all sizes, in reservoirs, dams, water-filled quarry holes and clay pits, and in ornamental ponds. Everywhere it is one of the most, if not the most, abundant of fresh-water fishes. The black-striped young in small schools of scores or hundreds, often associated with various minnows and other small fishes, parade and explore the shallows on all kinds of bottom except where densely grown with plants. The adults are found in deeper waters, in the channels, about the mouths of creeks, at dams, at the openings of sluices, and along the borders of dense growths of vegetation where they breed. Neither the adults nor the young, although they thrive in weedy ponds and even appear to prefer the vicinity of vegetation and though always active, are adepts at penetrating dense vegetation or working into the little pools and pockets of irregular shore lines. The young are very timid and are always ready to turn and run upon the slightest alarm. Possibly it is for this reason that although frequenting the shallows they seldom glean to the actual shore line. The roach is exceedingly prolific and propagates successfully in a variety of waters.

Several accounts of the food of the roach have been published. The results reported from localities in New York, Illinois, Michigan, and

Wisconsin differ considerably. The stomachs of adult fishes contained chiefly entomostracans (Pearse), caddis-fly larvæ (Baker), mollusks and insects (Forbes and Richardson), filamentous algæ (Hankinson, Pearse) or silt and mud (Forbes and Richardson, Pearse). Pearse (1918) has studied the stomachs of a number of young roach and found over 90 per cent Entomostraca, a few insect larvæ and pupæ, water mites, and considerable quantities of filamentous algæ and Volvox. He sums up (p. 252):

> Considering all things, it appears that when young the golden shiner feeds chiefly on entomostracans, and mature fish on almost any available organisms.

The author's observations on food were intentionally nearly confined to the young in the striped stage. The stomach contents of a few adults varied greatly, in one case consisting entirely of Lemna along with a heavy growth of diatoms and associated protozoans and rotifers. *Culex pipiens* larvæ were plentiful about the margins of the ornamental pond from which this fish was taken. In another the stomach was distended with a mass of winged flies, beetles, and bees to which the fish had evidently risen as they dropped into the water, besides a small quantity of plant remains. This fish was caught on a line in Ridley Creek at a point immediately adjacent to which was a spring-fed swale accessible from the creek through a drainage ditch in which both Culex and Anopheles were breeding freely. In other cases the contents of the stomachs of adults were similar to those of the young, except that the percentage of insects was usually higher.

The contents of 66 stomachs and intestines of young roach from 28 to 65 mm. long are reported in Table 1, page 12. About as many more were examined less thoroughly and found to have similar contents. These consisted chiefly of a dark greenish or greenish slate-colored mudlike mass, largely composed of filamentous algæ of various kinds, diatoms, desmids, Protococci, fungus spores, pollen grains, seeds, débris of vascular plants, the tests of protozoans, rotifers and insect eggs, together with some mineral particles. Taking the average of all the stomach contents, this comprised certainly more than one-half, or about 60 per cent of the volume. Next most frequent and abundant were entomostracans of various kinds, sometimes mixed, sometimes almost purely of a particular kind that happened to be abundant. Sometimes the food consisted almost exclusively of Cyclops, Daphnia, or Bosmina. The general percentage of entomostracans was estimated at 30 to 35. The remaining 5 to 10 per cent consisted of various insects, water mites, and small quantities of plant tissues. The insects were chiefly chironomid larvæ and adult flies, including in one case two adult male mosquitoes (*Aedes sylvestris*). In no case were mosquito larvæ or pupæ detected.

Observations of the feeding habits of these young both in nature when unalarmed and when confined in aquaria make it clear that a major source of their food is the surface film, consisting chiefly of animal and plant plankton, air-borne dust particles, etc., together with the very similar coating of slime abounding in minute organisms which covers the surface of plant stems, exposed roots, and other submerged objects and the surface layer of the bottom ooze. This harmonizes with the nature of the stomach contents and with the results published by Pearse.

TABLE 1.—FOOD OF 66 ROACHES (ABRAMIS CHRYSOLEUCAS).

Field number.	Locality and station.	Date.	Specimens reported.		Mosquitoes.	Other insects.	Crustaceans.	Minute animals.	Plants.	Remarks.
			Length in mm.	Number.						
18906a	Oakes' Pond, Essex County, N. J.	Sept. 6, 1918	42–52	10	....	A few eggs of Hemiptera.	Many ostracods.	Protozoans, rotifers, nematodes.	Filamentous algæ, diatoms, plant débris, spores.	Organic slime.
18905e	Pine Brook Bridge, Passaic River, Essex County, N. J.	Sept. 5, 1918	49–58	10	2 adult male Culex.	Small dipterous imagos of several kinds.	Many entomostracans.	Protozoa........	Confervæ, desmids....	Do.
18906f	Vanderbilt's Pond, Essex County, N. J.	Sept. 6, 1918	42–51	4	....	Several small chironomid larvæ.	A few entomostracans.	Some protozoans.	Some diatoms, Protococci, Confervæ.	Two stomachs empty, others contained little.
18905k	Fandango mill pond, Essex County, N. J. (pool at foot of dam).	Sept. 5, 1918	49–62	5	....	Chironomid larvæ and imagos.	A few copepods.	Many protozoans.	Large quantities of Oscillatoria, etc., some diatoms and desmids.	Mosquitoes bred freely in this pond in which there were no fish, owing to mill waste.
18816g	Westinghouse pond, near Essington, Pa.	Aug. 6, 1918	28–52	20	....	....	....	Protozoa, rotifers, mites, small worms.	Algæ of many kinds; spores, pollen grains, and vegetable débris.	A flocculent, slimy mass, filling both stomach and intestines.
18816o	Pumping station pond, Darby Creek, Hog Island project.	Aug. 16, 1918	28–50	10	....	....	A few copepods and ostracods.	.....do..........	.....do............	Do.
20813r	Duck Pond, Kenvil, N. J. (station No. 10).	Aug. 13, 1920	35–65	5	....	....	....	Difflugia, other protozoans.	Spirogyra, Œdogonium, Protococci, diatoms, desmids, débris.	Organic scum.
18919c	Mill Creek, near Bristol, Pa.	Sept. 19, 1918	60	2	....	Few fragments..	....	Many protozoans, water mites.	Mass of Spirogyra and scum, diatoms, desmids, Protococci, etc.	

Neither the published accounts of the food of the roach nor the author's notes record young stages of mosquitoes as actually found in the stomachs. This result was quite unexpected, as in beginning the investigation it was believed that the roach would prove one of the most useful species, and it was recommended as a probable mosquito destroyer during the first season. It was so regarded by Prof. Smith, who wrote (1904, p. 106):

> That this fish in its younger stages at least is an excellent mosquito control is proved by observing that wherever it occurs mosquito larvæ are absent, except in places which it can not reach. Experimentally it was proved by introducing a specimen into a water barrel swarming with wrigglers. In a couple of days it had devoured practically all of the larvæ and was then transferred to another barrel where its work was equally thorough, if a little slower. As against Culex this species is excellent, as against Anopheles and some other species that favor grassy areas it is of less account. Mr. Seal seems to consider it the only fresh-water minnow worthy of attention in this connection.

In a later paper Seal (1910) again recommends it highly.

Smith's observation that roach will partake of mosquito larvæ under artificial conditions has been verified by the author several times on the young fishes in aquaria and rain-water barrels. At one of the marsh pools on Darby Creek, below Philadelphia, a quantity of water filled with wrigglers was gently poured in proximity to a school of young roach, which snapped them up very quickly. On another occasion, however, when a boat containing rain water swarming with larvæ and pupæ of *Culex pipiens* was emptied at a sloping shore of Upper Kanawaukee Lake in Palisades Park, many young roach in the vicinity remained aloof, while other small fishes immediately rushed in and quickly devoured the insects.

Most of the stomach contents reported in Table 1 (p. 12) are from fishes taken in waters where mosquitoes were breeding more or less plentifully. This was notably the case at Oakes' Pond (No. 1890a) and Pine Brook Bridge (No. 1890e) in Essex County, N. J., and at the Westinghouse sluice pond (No. 1881g) and the Darby Creek pumping station pond (No. 18816o) of the Hog Island antimosquito project in Delaware County, Pa. At Oakes' Pond on September 6 hundreds of young roach were swimming in schools over a shelving gravelly beach and feeding on the outer side of a not very dense Elodea zone about 8 feet wide, while on the shore side of this barrier not a single one was seen, where in the shallow water among the rather sparse emergent vegetation Anopheles larvæ were present generally at an average density of nearly three per dipper and in places *Culex pipiens* larvæ at three to eight per dipper. At Pine Brook Bridge several schools of young roach kept in the current both of the Passaic River and of a small tributary stream, while a few feet away was a sheltered plant-grown offset where both Anopheles and Culex were breeding in moderate numbers. At neither place did the stomachs examined yield any trace of mosquito larvæ. At Westinghouse pond and the pumping station pond in August, 1918, large numbers of roach were taken, and in not a single case was a mosquito larva found in the stomachs, although they were at hand and were found in the stomachs of common sunfishes (Table 7, No. 18816d, p. 43) taken with the roach at the former place and in killifishes (Table 3, No. 18816m, p. 27) at the latter.

Further indications of the relative ineffectiveness of roach as mosquito killers were found in some of the experiments at Car Pond, N. Y. Here young roach were abundant along with mud minnows and young of the common sunfish as well as other small fishes. The roach and sunfish schooled separately but were found in the same places and frequently were taken in the same seine hauls. When obstructed shallow waters in which culicine mosquitoes were breeding abundantly were opened up, the roach did not enter them freely as did the sunfishes and mud minnows and the stomachs of the few that were actually taken within these areas yielded no mosquito larvæ, while those of mud minnows and sunfishes taken at the same time did. (Compare records under dates of July 12, July 15, etc., p. 16, 44, 45.)

The roach evidently fail to react strongly toward these conditions and do not push their way into the very shallow plant-grown waters where the mosquitoes breed. In all other respects they seem well qualified for mosquito control. They are widely distributed, abundant, unusually prolific, adaptable, and active, and they will eat mosquito larvæ but seem to lack the courage and enterprise to go after them.

While further experiments under other conditions will be necessary before a final conclusion is reached, the results of this investigation to date indicate that the roach has been much overrated as a mosquito destroyer. It has, nevertheless, a definite place and value in pond culture. Where ponds are stocked with bass, pickerel, or other predacious game fishes and it is desired to establish sunfishes for purposes of mosquito control, the simultaneous planting of roach would be an advantage. They will furnish abundant and natural food for the larger fishes and thus greatly reduce the destruction of the young sunfishes. For this purpose they are preferable to the species of Notropis, as they are not only more prolific but are less inveterate spawn eaters. That they will eat spawn of sunfishes during the absence of the owners from the nests has been observed by the author; but because of their timidity they are more easily held off by the fishes on guard than the bolder minnows and darters which will rush into the nests and often secure some of the tempting spawn whenever the attention of the guard is turned from their immediate direction. The success of the roach in life may be attributed mainly to its great fecundity and the adoption of the "safety-first" principle rather than to the possession of any of the heroic and aggressive qualities that characterize the sunfishes.

Furthermore, in so far as they compete with the young sunfishes for food, especially for Entomostraca and chironomid larvæ, they might be expected to drive them to a keener search for other more hidden food, including mosquito larvæ. Thus indirectly they might aid the purposes both of mosquito control and of food and game fish production.

GOLDFISH (Carassius auratus).

This well-known introduced species is widely naturalized and is frequently mentioned as a mosquito repressor. Indeed, it is a common practice to feed aquarium stock upon mosquito larvæ, as has been done at the University of Pennsylvania vivarium. The goldfish is largely a plant eater and scavenger, and all of the stomachs of both young and adults examined by the author contained almost ex-

clusively masses of filamentous algæ, pieces of roots and leaves of vascular plants, and such things as might be picked up in random feeding. In a few small ponds and reservoirs where the shore lines were clean and unobstructed and in which gold fishes only were present the author found practically no mosquito larvæ. This is also frequently the case in fountain basins. In such places there is but little food, and any larvæ that appear are probably quickly eaten by the hungry fish. For a number of years the author has kept several rain-water barrels free of mosquito larvæ by placing in each one or two small goldfish. If the fish died or was removed, the barrel would be abundantly populated within a few days with wrigglers usually of *Culex pipiens*, but occasionally of *Aedes triseriatus.* With the replacement of the fish the larvæ quickly vanished. A number of other fishes were tried, but, while not more efficacious, the goldfish lived longer than any of them, often even surviving the winters when the water in the barrels did not freeze solid.

These observations, therefore, fully confirm Smith's statement (1904, p. 107) that—

> the goldfish has its field of usefulness in fountain basins and in small artificial ponds not too much overgrown. In such places where it can reach the very edge of the water it serves very well.

It should be added that to produce the best results the fish should be fed little or nothing during the mosquito season, as small, hungry fish are many times more useful than overfed and overgrown ones. If multiplication be desired, a portion of the pond should be screened off in the spring with cellar window wire to provide a retreat for the young fry from their cannibalistic elders. The fry should be fed until established.

MUD MINNOW (Umbra pygmæa).

Jordan and Evermann give the distribution of this species as lowland streams and swamps coastwise from Long Island to the Neuse River. The closely related *Umbra limi* is found in the Great Lakes basin and northernmost part of the Mississippi Valley drainage.

In eastern Pennsylvania and New Jersey this interesting little fish is abundant in sluggish creeks and ditches having soft, muddy bottoms or luxuriant vegetation and in the shallow pools and holes of swamps and bogs where they spend much time buried in the mud or Sphagnum. In the shallow water, often only a few inches deep, of shaded swamps they often abound where no other fishes occur. They were also found commonly in the shallow weedy waters and swamps about the shores of lakes and ponds in Palisades Park. They are exceedingly hardy and will live a long time out of water or buried in the mud of drying pools, a peculiarity which they owe largely to their ability to respire in part by means of the swim bladder, probably assisted by the highly vascular fins, as in Amia.

No important published account of the food of the eastern mud minnow has been found, but the stomach contents of the closely related *Umbra limi* have been recorded by Pearse (1918), who reported upon a total of 110 stomachs examined and sums up the results of the studies of himself and predecessors as follows (p. 276):

> The mud minnow is a rather versatile feeder, with the chief constituents of its food, insects (35 per cent), entomostracans (31.3 per cent), and vegetation

TABLE 2.—FOOD OF 50 MUD MINNOWS (UMBRA PYGMÆA).

Field number.	Locality and station.	Date.	Specimens reported. Length in mm.	Specimens reported. Number.	Mosquitoes.[1]	Other insects.	Crustaceans.	Mollusks.	Other animals.	Plants.	Remarks.
2334	Car Pond, Palisades Park, opened pool, Globe Camp bay. J 6.	July 12, 1919, a. m.	....	3	3, 18. Culex pipiens larvæ, 6; pupæ 12. Corethra larvæ, 2.	Chironomid and mayfly larvæ and unrecognized fragments.	Entomostraca.	....	1 leech......	Fragments of leaves and stems.	Stomachs very full; some ooze.
2353a	.....do...........	July 15, 1919, p. m.	21, 48	2	2, 2+. Culex pipiens larvæ, 2 in one stomach; many hairs in intestines.	A few chironomid and one dragonfly larvæ.	Entomostraca in intestines.	....	....	Several large pieces of soft stem.	Intestines filled; little in stomach.
2359b	.....do...........	July 24, 1919, noon.	60, 73	2	2, ?. Hairs in intestines.	1 chironomid larva and unrecognizable fragments.	Many copepods.	....	Protozoans, 1 mite.	Filamentous algæ and tissues.	Little in stomach; digestion advanced; sand grains.
2363a	.....do...........	July 30, 1919, noon.	31–32	3	1, 1. Culex larva...	Many chironomid larvæ and tubes; undetermined fragments.	Large copepods.	....	....	....	Stomachs half full; digestion advanced.
2354	Car Pond, Palisades Park, small rock pool. J 4.	July 15, 1919, p. m.	21	1	1, 2. Culex pipiens and Aedes sylvestris larvæ, 1 each, full grown.	1 chironomid and 1 unknown larva.	....	....	....	....	Very little in stomach; intestine not opened.
2357a	.....do...........	July 24, 1919, late a. m.	30–56	3	3, ?. Culex larvæ, many broken siphon combs, mouth brushes and body hairs.	A large number of chironomid larvæ and pupæ in one.	A few Cyclops.	....	....	Débris........	Digestion advanced.
2361	.....do...........	July 30, 1919, a. m.	35	1	1, 1. Culex larvæ, a few bristles.	1 chironomid skin and tube and unknown fragments.	....	....	A few small eggs.	....	
2336	Car Pond, Palisades Park, head of Globe Camp bay, close to shore. J 3.	July 12, 1919, a. m.	48–62	4	....	Chironomid, dragonfly and Dytiscus larvæ.	A few Daphnia and Asellus.	Planorbis Ancylus.	....	Confervæ, diatoms, desmids.	
2356c	.....do...........	July 24, 1919.	42, 63	2	1, 1. Culex larva, fragments.	Dragonfly and mayfly nymphs.	A few entomostracans.	2 Planorbis.	Arcella and other Protozoa.	Spirogyra, diatoms, desmids.	Ooze.

2362c	......do............	July 30, 1919, noon.	55-65	3	1, 1. Aedes sylvestris, 1 siphon of half-grown larva.	Chironomid and dragonfly larva; podurans.	....	Planorbis...	....	Algæ and plant tissues.	
2330	Car Pond, Brooklyn Industrial cove. D 1.	July 11, 1919.	36-71	4	....	Several chironomid larvæ.	Few entomostracans.	....	Several sunfish eggs.	Some algal filaments.	Two stomachs empty.
2360d	......do............	July 24, 1919, a. m. late.	60-72	4	2, several. Culex pipiens larvæ, large number of fragmented siphons and other parts.	1 chirmonoid larva.	....	....	....	A few Lemna leaves.	Two stomachs empty; intestines not opened.
2364a	......do............	July 30, 1919, p. m.	33-71	10	5, 11+. Culex larvæ, mostly pipiens, some Aedes sylvestris; 11 siphons and many fragments of other parts.	Many chironomid tubes and larvæ in one, some in others; fragments of other insects.	Generally a few entomostracans.	Planorbis in two.	Protozoans..	Plant débris, desmids.	Four stomachs empty; content of intestines included, ooze and silt.
2377d	......do............	Aug. 23, 1919, a. m.	45-59	5	2, 2. Culex pipiens larvæ, siphons and mouth brushes.	Chironomid larvæ and remains of various other insects.	Entomostraca; 1 amphipod.	....	....	....	
18919d	Near Bristol, Pa., sluggish meadow creek.	Sept. 19, 1918.	17-50	3	....	Various insect larvæ, tipulid, chironomid, dragonfly, etc.	Cyclops, Asellus.	Planorbis, Physa.	Protozoans, mites.	Plant débris and protophytes.	One stomach empty; no mosquito breeding at this point where fishes were abundant.

[1] The first numeral in this column gives the number of individuals in which remains of mosquitos were detected; the second numeral, the total number of mosquito stages counted.

(13.6 per cent). Forbes and Richardson (1908) found that Wolffia and unicellular algæ formed three-fourths of the food of this species, insects and crustaceans making up the rest. Hankinson (1908) reported entomostracans, algæ, mites, midge larvæ, snails, and insects.

The detailed records show a much greater variety than this list would indicate, including many protophytes and protozoans, rotifers, oligochætes, leeches and nematodes, amphipods and isopods, spiders, and considerable quantities of silt and mud. It must be noted that of all the considerable number of individuals covered by these authors not a single one is reported to have eaten mosquitoes, though it is quite certain that some of them must have been taken from waters in which immature stages of mosquitoes were present. This may be taken as indicating the ease with which they may be overlooked rather than their total absence.

Most of the stomachs reported upon by the author (Table 2, p. 16–17) were collected in the course of experiments in Palisades Park from specimens 17 to 73 mm. long. The food is quite similar in general character to that of *Umbra limi*, but the percentages differ. Taking all of the stomach contents of the 50 specimens together, the approximate percentages of the principal items are: Insects of all kinds, 70 per cent or over; crustaceans (chiefly entomostracans), 12 per cent; mollusks, 6 per cent; plants (exclusive of protophytes), 4 per cent; organic mud and silt, containing large quantities of diatoms, desmids, protozoans, and other minute organic remains and débris, 5 or 6 per cent. Stomachs of individuals taken in the afternoon were generally empty or nearly so, while the intestines were full. Those taken in the early morning usually had the stomachs distended with food, much of which was little digested. The inference from this condition is that the mud minnow feeds habitually by night and fasts during the day while lying concealed in the mud and weeds. Many specimens taken in the ditches along the Delaware and Schuylkill Rivers in Pennsylvania and New Jersey had eaten much larger proportions of ooze and plants, but the diet was of the same varied character.

A comparison of stomach contents with conditions of collection and the progress of experiments clearly brings out the relation of the mud minnow to mosquito breeding. Of the 50 stomachs reported 22, or 44 per cent, were found to contain mosquito larvæ and pupæ, which formed about 4 per cent of the total contents, or about 6⅓ per cent of the insect contents. These remains represent 40 larvæ and 12 pupæ of *Culex pipiens* and *Aedes sylvestris* actually separated and counted. Probably others were present but not isolated.

The results of three experiments at Car Pond involving this species are now described. Station J 6 (figs. 2, 3) is a nearly circular hole about 7 feet in diameter and 20 inches deep situated in a little delta in the midst of a dense growth of tussock ferns at the mouth of Stahahe Brook which opens into the head of a shallow bay. Evidently the earth dug from the hole had been built up all around to form a solid dam, shutting off completely the deeper water of the brook on one side and the shallow water of the bay and marsh on the others. The pool was therefore completely isolated. The bottom was of soft ooze supporting a strong growth of Potamogeton and Utricularia, and a rank growth of grasses on the banks formed a pendant fringe. The water was foul with decaying vegetation and

swarming with Infusoria. When first discovered, on July 7, there was excessively heavy breeding (counts not recorded) of *Culex pipiens*. There were larvæ of all sizes, egg boats, and many pupæ, besides a few Anopheles. The bottom and water were thoroughly explored with seine and dip net and not a single fish found. Tadpoles, aquatic Hemiptera and Coleoptera, chironomid larvæ, copepods, Asellus, Physa, and Stylaria were plentiful, and there were some insect larvæ, amphipods, ostracods, Hydra, and a few Glossiphonia, Erpobdella, and Planorbis. Chironomid larvæ were especially abundant in the soft bottom mud. Outside of the hole mosquito larvæ were equally plentiful in little pools among the tussock ferns, but there was no breeding whatever on the brook side and only moderate breeding among the plants on the bay side of the pool.

On July 11 opposite openings were made in the banks, placing the pool in communication with the brook on one side and the bay on the other and inducing a current from the former to the latter. On the morning of the following day the use of the dip net immediately demonstrated the presence of mud minnows in the pool. The stomachs (Table 2, No. 2334, p. 16) of these were well filled and all contained larvæ of *Culex pipiens* and one of them no less than 12 entire pupæ of the same species. These, with two Corethra larvæ, comprised about 35 to 40 per cent of the entire stomach contents, the remainder being 12 per cent of the larvæ and pupæ of other insects, chiefly chironomids and mayflies, about the same of entomostracans, and small amounts of ooze, plant remains, and miscellaneous matter, including one leech. It will be noted that these newly admitted mud minnows accepted animal food in the approximate order of its abundance and accessibility.

On July 15 only two mud minnows were secured, along with a few sunfishes. They were taken in the afternoon and their stomachs (Table 2, No. 2353a) contained little. Two Culex larvæ were found in one, none in the other, most of the food being chironomid larvæ, some larvæ of other insects, and a quantity of mud and plant remains. Ten water samples yielded a total of 30 larvæ and 1 pupa of *Culex pipiens*, an average of three, and a very striking decrease in four days. In the undisturbed small pools among the tussocks every sample yielded 28 to 30 or more larvæ besides some pupæ and egg boats.

On July 24 two mud minnows were again taken from the pool, together with two sunfishes and a large number of young minnows (Notropis). On this date mosquito breeding had fallen to an average of less than one-third larva per sample, but in the check pools remained undiminished. None of the stomachs of any of the fishes examined yielded undoubted mosquito remains. The collection was made close to noon and the food (Table 2, No. 2359b) of the mud minnows was in an advanced stage of digestion. It consisted chiefly of fragmented insect remains, including many chironomid larvæ, many copepods, and much of the mudlike material containing filamentous algæ, protozoans, protophytes, plant débris, and sand grains. In the intestines were some broken hairs that may have come from mosquito larvæ.

On July 30 three stomachs (Table 2, No. 2363a) contained one *Culex pipiens*, many chironomid larvæ in tubes, large numbers of a large Cyclops, and some insect remains. Ten samples yielded

two Culex larvæ. Throughout the remainder of the summer breeding here remained at the same low point, and this was true on the author's visit in August, 1920.

J 4 (figs. 4, 5) is at the side of the same bay, about 20 yards from J 6. Many loose rocks are tumbled about on the shore here, and among them are numerous pockets into which the water seeps, forming little pools quite cut off from direct communication with the lake waters. The brook previously mentioned flows past this shore, carrying clean water 18 inches to 2 feet deep up to the very rocks that bound the outermost of these pools. Large numbers of small fishes, chiefly schools of young sunfishes, roach, and minnows, are constantly swimming along this shore, and mud minnows may always be seined. Many of these pools are separated from the lake waters by single rocks a foot or less across, yet are quite shut off from access to the fishes which come to the outer side of the barrier.

On July 11 and 12 this place was thoroughly studied and a number of the pools selected and marked for various experiments. Others were filled with earth by the laborers. Those pools nearest to the lake usually supported a good growth of Lemna and filamentous algæ and abounded in diatoms, desmids, rhizopods, ciliates, and other microscopic life, together with many entomostracans, minute oligochætes, and a few amphipods, aquatic insects and their larvæ, leeches, etc. To the hand the water seemed warmer than the circulating water of the lake but was always clean and pure. In all of these pools mosquito breeding was very dense, while in the lake only a foot or two removed there was little or no breeding except where obstructions of driftwood or vegetation had accumulated.

Selecting for further discussion one of these pools about 2 feet in diameter (fig. 4) and another immediately contiguous one about 14 inches in diameter for a check, both of which were separated from the lake water by not over 15 inches of rock, the mosquito count gave numbers running from 20 to upward of 50 larvæ of *Culex pipiens* and *Aedes sylvestris* for each sample. As many were newly hatched the actual number present probably exceeded the counts. In addition there were some egg boats and pupæ and an occasional Anopheles larva. Thorough exploration with a small dip net failed to disclose the presence of any fishes in the pools.

On July 12 mud minnows (Table 2, No. 2336, p. 16) seined in the lake at this point contained no mosquitoes but various insect larvæ, gastropods, entomostracans and isopods, diatoms, desmids, Confervæ, and silt. At the same time by removing a single stone an opening 6 or 7 inches wide was made into the larger pool, no change being made in the smaller one.

On July 15 a single small mud minnow (Table 2, No. 2354) was taken from the opened pool. Its stomach contained two full-grown culicine larvæ and two other insect larvæ. On this date there was little if any diminution in breeding (average 36 per sample).

The opening was enlarged and made more direct. On July 24 great numbers of young sunfish were swimming in schools along the shore, and a number of these, together with three mud minnows, were taken from the pool. In the latter (Table 2, No. 2357a) in a mass of much fragmented material were many body hairs, siphon combs, and mouth brushes of larval Culex, some Cyclops, débris,

and in one specimen a large number of well-preserved chironomid larvæ and pupæ. In 2 stomachs of fishes (No. 2356c, p. 16) taken at the same time just outside of the pool were remains of 1 Culex larva, a small dragonfly nymph, 2 small Planorbis, 1 mayfly nymph, a few filaments of Spirogyra, and fine débris containing remains of entomostracans, protozoan tests, diatoms, and desmids. The larval count had fallen to an average of 3.6 per dipper, just one-tenth of what it was on the previous count, while in the check pool the number of young larvæ was so great that they could not be counted accurately, the actual counts running to 40+ and 50+ per dipper.

On July 30 only one small mud minnow and no sunfish were found, their absence probably being accounted for by the presence of a water snake in the pool. The minnow (Table 2, No. 2361) contained remains of Culex larvæ, chironomids, undetermined insects, and some small insect eggs. Mosquito counts ran from 0 to 10 (average, about 4) per dipper, no pupæ, and a few egg boats. In the check pool breeding had increased if anything, the counts running from 45 to over 80, of which about 20 per cent were large or full grown, the rest of various sizes, largely newly hatched, pupæ about 2 or 3 per dipper and egg boats as in the opened pool. Mud minnows (No. 2362c) taken from the lake close to the pools contained 1 *Aedes sylvestris* larva, a few chironomid larvæ and other insect remains, snails, and a small quantity of algæ and plant tissues.

A third experiment (D 1) involving the mud minnow was on a larger scale. An area of about one-third acre at the head of the cove above Brooklyn Industrial Camp was much obstructed by driftwood (figs. 6, 7). Many logs had stranded on the bottom in shallow water or had lodged on the projecting rocks and the few drowned trees left standing. Reinforced by large quantities of débris and Lemna, together with some emergent and marginal vegetation, these formed a barrier to the entrance of fishes. When this area was first examined on July 5, culicine mosquito breeding was very general but unequal, varying from an average of 30+ larvæ per sample in the more obstructed parts near shore to 4 per sample in the outer parts. Most of these were third and fourth stage larvæ, together with a few pupæ of *Culex pipiens* and all ages of *Aedes sylvestris*. On account of the many snags seining in this area was ineffectual, but thorough dip-net explorations discovered no fishes except on the outer margins. Tadpoles, newts, water bugs and beetles, many kinds of insect larvæ, etc., were taken in the abundant Ceratophyllum. It is possible that a few mud minnows may have escaped detection, but there were certainly not many in the more obstructed parts near shore.

On July 10 and 11 most of this area was cleared of obstructions (fig. 8). On the 11th large numbers of sunfishes and mud minnows were seined on the border of the opened area. Stomachs of four of the latter (Table 2, No. 2330, p. 17) yielded no mosquitoes but many chironomid larvæ, some entomostracans, and considerable mud with diatoms, desmids, etc. One contained some eggs of sunfishes which were nesting a few yards away on a gravelly beach.

Of fishes taken here on July 24 four mud minnows (Table 2, No. 2360d) were examined. The stomachs of two were empty, the others contained many larvæ easily recognized by their siphons as *Culex*

pipiens. These made up the bulk of the food, the only other contents being Lemna plants and one midge larva. Culex larvæ at this point ran regularly 2 to 4 per sample, except in some of the inaccessible pockets where the number rose to 20+ to 30+. These were of all sizes, including some of *Aedes sylvestris* and a few pupæ.

Of mud minnnows taken on July 30 (Table 2, No. 2364a, p. 17) 10 stomachs were studied; 4 were empty, 5 others contained a total of 11+ Culex larvæ and remains of a large number of chironomid larvæ in tubes, some fragments of other insects, some entomostracans, 3 Planorbis, and some protozoans and desmids. On this date general mosquito breeding in these opened waters was practically abolished, only an occasional larva being found except in some better protected indentations of the shore where the counts averaged from 6 to 8. Most of these were obstructed by rafts of Lemna and were doubtless the source of most of the mosquito larvæ found in the stomachs.

These three experiments are typical of a number and are selected because the results appear to be unequivocal. No change whatever was effected in these natural breeding places of mosquitoes other than to open them to the active life of the lake and especially to the small fishes. Just as far as the latter penetrated, the density of the mosquito breeding steadily declined during July and August while observations continued. In undisturbed portions of each station left as checks the original rate of breeding was maintained. Other stations at which similar experiments were conducted were sometimes tampered with or may have been subject to other influences which might contribute toward repression of mosquito breeding. The most important of these are wind and wave action, from which these three experiments were perfectly sheltered, the use of oil, which was not employed in the vicinity of any of these stations, and the effects of copper sulphate used in the lake against water bloom but not used in this area during the progress of the experiments.

The results, taken in connection with others, appear to the author to establish the value of the mud minnow as a factor in mosquito repression. It is, of course, not meant to credit this species with all or even most of the reduction in numbers of larvæ. As will be shown later, that credit belongs in larger part to the common sunfish.

The reverse experiment of excluding mud minnows as well as other fishes from open areas free from mosquito larvæ was made both near Philadelphia and in Palisades Park by means of wire screens and earth dams. In due time most of these pens became prolific breeding places of culicine mosquitoes which grew to maturity undisturbed except when the pens were opened, when the larvæ quickly disappeared. This was repeated many times. As all fishes were excluded it is not possible to differentiate the specific part played by Umbra. There was not time to arrange experiments to attempt this differentiation, but this may be done later.

Prof. Smith (1904, p. 112) writes of the mud minnow, after stating that one left in a bottle over night with a lot of wrigglers ate them all, that—

> in these very pools known to be inhabited by these minnows there are always plenty of larvæ to be found, so that Mr. Seal is probably quite right in his conclusion that the species is unworthy of consideration in this connection.

In a later paper (1910) Seal considerably softens this verdict.

The author's observations are in harmony with and explain this statement. It is quite true that in swamp puddles where no other fishes occur culicine mosquitoes of several species will sometimes breed in association with mud minnows. While in the numbers in which they commonly inhabit such places the mud minnows may be considered inadequate in their influence, it is nevertheless probable that without their services a much larger number of these mosquitoes would mature. The mud minnows have the very great merit of penetrating the swamp pools, the nooks and crannies of the banks of ponds and ditches, and the dense growths of vegetation, as well as into foul waters, places where no other mosquito-eating fishes native to this region habitually go. Perhaps their chief deficiency is in numbers. Nowhere are they sufficiently numerous to alone keep mosquito larvæ down. However, their cryptic habits cause them to be overlooked, and they are often much more plentiful than one would expect. They lie concealed in mud, under stones and logs, and in vegetation, and large numbers may be had if one goes after them in the right way. They are so hardy that it is probable that they could be propagated artificially and planted in swamps and other waters where they would prove useful. Further work in this direction is recommended.

COMMON KILLIFISH (Fundulus heteroclitus).

The common killifish is distributed along the entire Atlantic and Gulf coasts of the United States, according to Jordan and Evermann from Maine to the Rio Grande. This is essentially a tidewater species, equally at home in the network of thoroughfares and creeks of the salt meadows of New Jersey, the brackish estuaries and affluents of Delaware Bay, and the creeks and ditches of the fresh-water tidal flats of the Delaware River system as far as Trenton.

In countless millions the killifishes move with the flood tide up the little creeks, draws, and ditches, and as the rising waters spread over the flats, penetrate to all parts of these, retiring again with the ebb to the permanent deeper waters of the larger creeks, rivers, and thoroughfares. Thus twice daily during most of the mosquito-breeding season, the entire accessible area of these coastal and river marshes is invaded by hosts of hungry active little fishes seeking for food. In the salt and lower brackish regions this killy is accompanied by several other species chiefly of related cyprinodonts, but in the fresh waters associated fishes are neither numerous nor regular in their movements. As the tide recedes many killies are left stranded, and either remain in little pools or more often wriggle over the mud to regain the receding waters. They have also become landlocked in ponds and obstructed parts of ditches, and will breed in such places as well as normally and usually on the gravelly shallows of the creeks and rivers. Many warm shallow pools literally swarm with the young during the summer.

The value of this species in limiting the numbers of the salt-marsh mosquitoes is thoroughly established and attested by scores of anti-mosquito workers in New Jersey, New York, and Connecticut. The method of ditching of the salt meadows worked out by Prof. Smith and now extensively applied under the direction of Prof. Headlee and the several county mosquito extermination commissions of New Jersey is essentially based on the principle of concentrating breeding

in places fully accessible to the killies, and although vast numbers of the larvæ are killed by the rapid drying of shallow pools the measure of control is chiefly determined by the success with which this principle has been applied. This is shown by numerous cases where long continued rains have kept in a flooded state portions of the meadows usually well drained but not open to the fishes, by the effect of obstructed drainage ditches and of construction work which interfered with the movements of and renewal of the supply of killies, and by the results of the repellent influence on the fishes of contamination of certain waters by manufacturing wastes. In many such cases the areas affected, some of them extensive, have produced great swarms of mosquitoes which quickly waned whenever the barrier conditions were corrected and the killies permitted to do their work. A volume might be filled with the description of such instances. Headlee and Carrol (1919, p. 17) write:

Two natural agencies limit or entirely eliminate the broods. If the weather is bright, the shallow sheet water covering large areas of marsh surface and filling the shallower pools is quickly evaporated and the wrigglers die. The deeper pools harbor small killifish, which promptly eat all wrigglers that may appear. The result is that comparatively few mosquitoes get on the wing. If, however, the weather is cloudy and the atmospheric moisture high, the sheet water disappears very slowly and an enormous brood of mosquitoes may escape. If the covering tide is very high—so high as to bury the meadows deeply—killifish penetrate everywhere, and whether the weather is bright or cloudy prevent the emergence of a large brood of mosquitoes by eating up the wrigglers.

Under these conditions it seems remarkable that the similar relation which these fishes bear to the fresh-water tidal swamps should be so little appreciated. For example, one sanitary officer having direction of an extensive antimosquito project involving large areas of such swamp told the writer that the use of fishes in such an area was not a practical proposition. For this reason a general study of mosquito-breeding conditions in the marshes bordering both sides of the Delaware River was made, especially favorable facilities being afforded through the interest of William V. Becker, the engineer in charge of the operations in the Hog Island region. A full description of the many interesting and sometimes exasperating conditions in this rapidly developing industrial district would require too much space, but a brief summary may be given.

Broadly considered, three sets of conditions prevail. First, there are the natural tidal swamps bordering the river and the lower portions of its tributaries. These are intersected by a network of creeks and channels and for the most part covered with a heavy growth of reeds. At flood tide they are covered ordinarily with shallow water which again drains off with the ebb but leaves numerous small pools and puddles. Second, are the reclaimed tidal swamps, rich alluvial lands originally taken up for agricultural purposes but now mostly either neglected meadows or passing over to industrial uses. These are inclosed by dykes and drained by systems of ditches emptying into the river by sluiceways guarded by automatic tide gates. Sometimes the drainage ditches are supplemented by wider canals originally designed to facilitate transportation about the farms. Many of these drainage systems are very old, dating back to the original settlers. With the industrial development of the Delaware River front many of them have become obstructed, disarranged, or neglected. The

tide gates often fail to function properly; the ditches are grown with vegetation; and inasmuch as most of these protected areas lie below the level of high water natural drainage is sluggish and numerous more or less permanent pools are formed. Third, bordering the tidal marshes and often the meadows and extending as a fringe up the creeks at and just above the limit of tide action is a zone of typical fresh-water swamp varying in width with the topography. Islands of this character also occur within the tidal area.

The mosquito pests in this region are produced chiefly under the second and third conditions. Prolific breeding is almost universal where these conditions occur uncorrected. Under the first condition it is exceedingly rare to find a mosquito larva in any place open to free circulation of water. It is only on the margins of the tidal area or at points where obstructions occur that breeding is found. This corresponds exactly with the natural distribution of the killifishes. They range freely with the tides, and mosquito larvæ do not thrive in places to which they have easy access. While physical conditions in the actual tidal currents are unfavorable to mosquito development, there are large areas perfectly suited to it where larvæ are rarely or never found. Furthermore, wherever on such areas obstructions occur which bar the entrance of the killies, such as dense growths of vegetation at the heads of ditches and alterations due to construction work, which are frequent in this region, there breeding is likely to occur. On the other hand, under the second and third conditions instances were found where the killies were admitted to ditches or creeks or had been planted in gravel pits and ditches filled with stagnant water in which there was no mosquito breeding. Throughout this whole region the contrast between mosquito producing and nonproducing areas in their relation to tidal action and killifishes is most striking. Almost invariably areas deprived of killifishes from whatever cause become sources of prolific breeding of *Culex pipiens*, while similar areas to which the killies have access are free from larvæ. There need be added only brief accounts of a few specific examples selected from a large number.

In the midst of an undyked and tide-swept area on Darby Creek, not far from Corbindale, is an old farm now abandoned for agricultural purposes. The drainage ditches on a dyke-inclosed field of perhaps 20 acres have become so clogged and filled that they are altogether ineffective. Surface water has filled what remains of the ditches and has spread in a shallow sheet over the surface generally, its depth varying with the rainfall. The whole field is heavily grown with reeds, with patches of cat-tails and marshmallows in the deeper pools, and a border of grasses, giant ragweed, and Cephalanthus. It has reverted to the condition of the tidal marshes without the tides and killifishes. Throughout the summers of 1918 and 1919 *Culex pipiens* bred heavily throughout this area. They were found by the author on visits made on July 26, August 16, and September 13, 1918, and on June 25, 1919, and they were reported frequently by Vernon Lockwood. On none of these occasions were any Funduli found except on the last date a few in one of the closed ditches. Immediately across the dyke bounding this field on one side is a section of the natural marsh, and a wide open ditch which carries the tide to it. This ditch and its laterals always swarmed

with killies, and near low water multitudes were seen in the pools or wriggling across the mud. Except in a narrow fringe around the landward side of this marsh, beyond free tidal action and the reach of the killies, no mosquito breeding was detected here.

On September 13 a pool about 70 by 40 feet, cut off by the extension of a new railroad embankment across a large ditch, was examined. In it were numerous landlocked killifishes (Table 3, No. 18913g, p. 27), and not a single mosquito larva could be detected anywhere. Across an old railroad embankment bounding this pool on the other side, and separated from the latter by the width of this embankment only, was a similar but smaller and much older pool. This was alive with all stages of the young of *Culex pipiens*. No killifishes could be seen or found with a minnow seine. One hundred of the fishes were transferred from the first to the second pool and immediately began to feed actively upon the larvæ and pupæ. The author was unable to visit this pool again to determine the final result. A number of pens and inclosures placed along another section of Darby Creek to test the mosquito-eating capacities of the killies were destroyed or tampered with by meddlers, but the experiments of Viereck (*in* Smith, 1904), Chidester (1916), and others on the salt marshes furnish all needed evidence on this point.

Contamination of water may serve as a bar to the killifishes. A number of examples of this were met with, and the reports of the New Jersey Mosquito Extermination Association record several. One such case affected an extensive area along Darby Creek. In 1917 a large manufacturing plant emptied great vats of strongly alkaline water into the creek. Probably as a result of the consequent change in the normal acidity of the water the killifishes abandoned a stretch of the creek exceeding a mile in length for a period of several weeks. The result, which appeared to be directly connected with the absence of the fishes, was that a great brood of mosquitoes matured on this area where but few were produced before and after.

Little has been published relating to the food of this species, the most important being the paper by Chidester (1916), who writes (p. 11):

> Examinations of the stomachs of adult Funduli showed that they eat larvæ, pupæ, and adults of all the salt-marsh mosquitoes. They also eat Dytiscus, Notonecta, and many Daphnids. In the winter small quantities of algal matter and a few small shrimps constitute the most of the food of the active individuals. In the early fall the chief food besides mosquitoes seems to be insect and snail eggs and occasionally a few fish eggs.

The author has examined 42 stomachs of this killy, mostly taken from the fresh waters below Philadelphia (Table 3, p. 27). In only four cases were mosquito larvæ found. One was in a fish one-half inch long taken on the tidal flats of Darby Creek on July 26 (No. 18726k). The other food was ostracods and copepods. Two others were from the pumping station pond (No. 18816m). The stomachs of adults contained large quantities of organic ooze with plant débris, minute animal and plant life, oligochætes, mollusks, entomostracans, and insect larvæ. In some cases the sole stomach content was Spirogyra and other Confervæ.

May it not fairly be claimed that the use of Fundulus on the salt meadows is the classical example of the employment of a natural agent in mosquito control and that no other species of fish, not even

TABLE 3.—FOOD OF 42 COMMON KILLIFISHES (FUNDULUS HETEROCLITUS).

Field number.	Locality and station.	Date.	Specimens reported.		Mosquitoes.[1]	Other insects.	Crustaceans.	Mollusks.	Other animals.	Plants.	Remarks.
			Length in mm.	Number.							
18726k	Near mouth of Darby Creek, Delaware County, Pa., Wanamaker Avenue, tidal flats, flood tide.	July 26, 1918	12–36	10	1, 1. Culex pipiens larva.	....	Stomachs filled with ostracods and copepods.	1 Pisidium	1 water mite, setæ of aquatic oligochætes.	Leaf and stem tissues, Confervæ and diatoms.	Small killies cover the flats in great numbers at high water.
18730d	Goshen, N. J., Goshen Creek.	July 30, 1918	48–60	7	.....do............	A few chironomids and beetles.	Ostracods.....	....	Protozoans....	Diatoms, Confervæ, vegetable débris.	Much organic mud.
18816h	Westinghouse pond, near Essington, Pa.	Aug. 16, 1918	34–65	10	....	Chironomid larvæ in three stomachs, 1 mayfly.	Entomostraca in most.	....	Many protozoans and rotifers.	Oscillatoria principal and with Spirogyra often nearly sole food; Protococci.	Silt and plant débris.
18816m	Darby Creek, pumping station pond.	.....do........	40–48	5	2, 3. Culex pipiens larvæ.	Chironomid and mayfly larvæ and water bugs (Nepa), small beetle.	Considerable number of copepods and ostracods.	Physa in two.	Mites, aquatic oligochætes.	Filamentous algæ, plant tissues and débris.	Small amount of silt.
18913g	Darby Creek, near Essington, Pa.; pool isolated by railroad embankment.	Sept. 13, 1918	33–53	10	....	Insect (hemipterous?) in one.	Entomostraea in nearly all.	Physa in four, 80 per cent in one.	Protozoans frequent, oligochætes and eggs frequent, Plumatella in one.	.....do.........	Silt and débris.

[1] The first numeral in this column gives the number of individuals in which remains of mosquitoes were detected, and the second numeral the total number of mosquito stages counted.

Gambusia, is employed so successfully or on so large a scale? However, much yet remains to be done. The slightly brackish and fresh marshes of the Delaware and other rivers and the estuaries of Chesapeake Bay have scarcely been touched, and most of the work done there has taken little account of the fishes that are at hand to help. It seems probable that on many tracts where actual reclamation work has not been or is not to be done methods similar to those employed on the salt marshes, with modification of the form and arrangement of the ditches to suit the different conditions, would be equally successful.

Fundulus heteroclitus has also been recommended for transplantation into upland ponds, and some experiments of this kind have been made, but the author has been unable to follow the results sufficiently to form a definite opinion. Undoubtedly this killy is sufficiently adaptable and hardy to withstand the change, but its behavior in relation to the tides is so pronounced that it seems hardly probable that it will thrive and propagate entirely away from their influence. It is very desirable, however, that such experiments should be carried to a conclusion.

TRANSLUCENT KILLIFISH (Fundulus diaphanus).

The translucent killifish is found from Maine to Cape Hatteras along the coast as well as inland and is continued westward to the Mississippi River by the subspecies *menona*. Though found in the salt waters of the back bays and throughfares this is particularly a brackish and fresh-water species, abundant in the river systems of the New England and Middle Atlantic States, and unlike the common killifish is a common fish of the upland waters. It is exceedingly abundant in many of the streams and ponds of the Delaware River drainage and in similar situations in northern New Jersey and southern New York.

The author's studies on the translucent killifish have been limited chiefly to observations made in northern New Jersey, though the fish was met with at Philadelphia and in Palisades Park. Like the other killies it is gregarious and frequents the shallows, where it feeds at both bottom and surface, and penetrates into the intricacies of the banks and among open vegetation. As it breeds freely in landlocked fresh waters it is readily established in upland ponds.

The writer knows of no detailed account of the food of the eastern form, but the subspecies *menona* has been thoroughly studied by Pearse (1918) and Forbes and Richardson (1908). The former summarizes the contents of 149 stomachs, in percentages, as follows (p. 262):

> Fish embryos, 0.8; insect eggs, 0.8; insect larvæ, 23.4; pupæ, 1.7; adult insects, 2.7; mites, 3; amphipods, 14.1; ostracods, 15.7; copepods, 4.9; cladocerans, 15.3; Sphæridæ, 0.4; snails, 3.5; oligochætes, 2; nematodes, +; plant remains, 5.5; algæ, 0.9; silt and débris, 4.2.
>
> The top minnow ate 36 per cent entomostracans and 28 per cent insects, as well as amphipods, plant remains, the débris from the bottom and the surface of plants, mollusks, etc. Forbes and Richardson (1908) reported the food of this species to be insects, amphipods, snails, and plant seeds. The large percentages of ostracods, oligochætes, and Chydoridæ and the species of insect larvæ found in the present investigation indicate that the top minnow frequently feeds near the bottom or among vegetation.

No mosquito larvæ are reported to have been found, though chironomid larvæ were common.

TABLE 4.—FOOD OF 48 TRANSLUCENT KILLIFISHES (FUNDULUS DIAPHANUS), SEPTEMBER 6, 1918.

Field number.	Locality and station.	Specimens reported.		Mosquitoes.[1]	Other insects.	Crustaceans.	Mollusks.	Other animals.	Plants.	Remarks.
		Length in mm.	Number.							
18906b	Oakes' Pond, Essex County, N. J. beach.	30–52	22	3, 4. Culex pipiens larvæ, 3; Anopheles larva, 1.	Many chironomid larvæ; some other insects.	Miscellaneous entomostracans often in large numbers.	....	Aquatic oligochætes.	Confervæ, diatoms, both solitary and chain.	
18906g	Vanderbilt's Pond, Essex County, N. J.; pool below dam.	34–60	10	....	Fragments of various kinds.	Ostracods........	....	....	Vegetable débris and algæ.	Stomachs mostly empty or nearly so.
18906i	Vanderbilt's Pond, Essex County, N. J.; pool above dam.	34–54	4	1, 1. Culex pipiens larva.	One entirely filled with chironomid larvæ; stone-fly larva; 1 adult fly.	Ostracods in two; one Asellus.	Three Pisidium in one.	....	....	
18906m	Davies' Pond, Essex County, N. J.; outlet; beach.	24–60	6	....	Some chironomid larvæ in all; Tanypus pupa in one; beetle larvæ and eggs; may-fly larvæ.	Principal food, Entomostraca of much variety.	....	Water mites..	Lemna leaves; Confervæ.	Stomachs packed with food; no mud.
18906p	Davies' Pond, Essex County, N. J.; wooded shore, mud.	23–48	6	....	Some chironomid larvæ; two small dragonflies and several unknown larvæ; insect eggs.	A few Entomostraca.	....	Protozoans....	Considerable Confervæ and diatoms.	Organic mud.

[1] The first numeral in this column gives the number of individuals in which remains of mosquitoes were detected; the second numeral, the total number of mosquito stages counted.

The contents of 48 stomachs of fishes taken in ponds and streams in northern New Jersey reported in Table 4 (p. 29) agree fairly well with Pearse's statement. Chironomid larvæ constituted the largest single item, or about 33 per cent; other insect remains, 11 per cent; crustaceans (with the exception of a few isopods, all entomostracans), 19 per cent; miscellaneous animal remains, 13 per cent; and plant remains, mostly filamentous algæ, organic ooze, and débris, 20 per cent. A single *Culex pipiens* larva was found in each of two stomachs, two in another, and an Anopheles larva in still another. Three of these fish came from Oakes', the other from Vanderbilt's Pond. All of these were taken in September, and it is of interest to compare conditions in the three ponds selected for illustration, from two of which they came. All are located on Third River, a tributary of the Passaic, in a series of which Oakes' is the uppermost and Vanderbilt's the lowermost.

Oakes' Pond in large part was heavily grown to aquatic and emergent vegetation, particularly at the much silted-up head, and at the time of the author's visits was so bad a breeding place of *Culex pipiens* and Anopheles that the Essex County Mosquito Commission had declared it a nuisance and was cooperating with the owners in revising its shores and channel. Small fishes were found in moderate numbers, the species collected being roach, translucent killifish, young carp, and chub sucker. Roach were most plentiful. The point at which those reported upon were taken is a bit of open shelving beach free of vegetation. On each side of this was a zone of Elodea extending continuously as a barrier a few feet from the shore. In the space behind the Elodea was a growth of emergent plants chiefly composed of Sagittaria, Pontoderia, Polygonum, sedges, and grasses of varying density. Here *Culex pipiens* and Anopheles were found generally in numbers varying from place to place. No larvæ were found in the open space at the beach. Of 22 killies (Table 4, No. 18906b) examined at least three had eaten mosquito larvæ, which they must have secured behind the Elodea barrier. The principal food was chironomid larvæ, aggregating about 60 per cent of the total contents. It should be noted that none of the young roach which were taken at the same place and time were found to contain mosquito larvæ.

Davies' Pond, lying next below Oakes', is generally similar but was noted to differ in the following respects: It was less filled with silt, and the vegetation, though similar, was less dense. On one side it was heavily shaded by a wood of large trees, and the bank here was fairly steep with little marginal or emergent vegetation. On the other side, which was also shaded but less densely, the water was very shallow, with the Elodea zone sparse and far out. There was consequently a broad inner zone of open water nearly free from vegetation in which killifishes were seen in large numbers and some collected (Table 4, Nos. 18906m and 18906p). At all points around the shore this species was encountered in large schools, and it was practically the only species of small fish present. Personally the author failed to find a single mosquito larva in this pond, and Mr. Brooks stated that the inspectors always reported practically no breeding here.

Vanderbilt's, the next pond below, is a larger body of water, which has a bad reputation among the Essex County inspectors as a source

of mosquito breeding. It had recently been drained and refilled, and at the time of the examination no larvæ were found, though the author had been assured that they were always present in considerable numbers. The shores of the pond were heavily grown with brush to the water's edge, and the growth of emergents at the head was dense. At the foot, toward the dam, the growth of Elodea was very dense and the water was full of accumulated decaying vegetation evolving decomposition gases. No fishes were seen anywhere in the pond, and the seine brought to light only a very few young roach and killifishes. Of four (Table 4, No. 18906i, p. 29) of the latter examined one contained a Culex larva, while the same number of roach yielded no mosquito stages. In a pool below the dam, however, the killies were present in considerable numbers, possibly having been carried out when the water was drawn off. Of 10 (No. 18906g) of these examined the stomachs were mostly empty.

The facts that it is desired to emphasize are: (1) That the translucent killifish does eat mosquito larvæ, to a limited extent at least; (2) that in the very pond where this species was most abundant and the shore conditions most favorable to its action, mosquito breeding was practically nonexistent; and (3) that in adjoining ponds where fewer of the killies were present and where plants grew more luxuriantly, both Culex and Anopheles bred freely. While the species was met with in other ponds and creeks no observations of value were made. Some experiments to test its practical value were suggested to the Essex County commission, but nothing seems to have been done, and there was no opportunity for personal experimentation.

Little is known of the translucent killifish in relation to practical mosquito control. Seal (*in* Smith, 1904) advises against its introduction for this purpose "because it would destroy the eggs and young of more valuable species, which are by nature better adapted to landlocked or stagnant waters." Pearse's investigations show only 0.8 per cent of such food, and it is doubtful if this killy is greatly more culpable in this respect than most of the fresh-water minnows. It is certainly quite as well adapted to many mosquito-producing waters and more efficacious as a mosquito destroyer than they. For muddy ponds and sluggish streams the author would recommend it much in preference to the common killy, but experimentation is much to be desired.

TOP MINNOW (Gambusia affinis).

The natural range of this top minnow is from Delaware throughout the South Atlantic and Gulf States and up the Mississippi Valley to Illinois. It is an inhabitant of shallow estuaries, sluggish creeks, lagoons, ponds, and marshes and is equally at home in brackish and fresh waters. While preferring clean water, it will live in that which is most extremely foul, as the writer observed in drying borrow pits in Louisiana. It is excessively abundant in the South.

The value of this little fish in the natural suppression of mosquitoes, and especially of the anopheline mosquitoes, has long been recognized, and in the South, during the war period and since, it has been extensively and successfully utilized in the antimalaria cam-

paign. The conditions of its utilization have been especially worked out by Hildebrand (1919), and some of its ecological relations by Barney and Anson (1921). For the purpose of mosquito control Gambusia is almost ideal. Its natural predilection for the aquatic stages of mosquitoes as food, its vivaparity and fecundity, its hardiness and adaptability to a great variety of aquatic habitats, and particularly its fitness to the marsh and swamp associations to which mosquitoes naturally belong, its top-feeding habits, small size, great activity, and proneness to penetrate into the shallowest waters and dense vegetation, and its wide distribution and abundance are among its outstanding merits. Within its natural geographical range its value may be taken as fully established, and it has been successfully planted and employed against mosquitoes in other warm districts, as in the Hawaiian and Philippine Islands. A related species has been utilized recently in Mexico.

As long ago as 1904 Seal experimented with this fish and pointed out its great promise as supplementing the native fishes found in New Jersey, especially in relation to the anophelines. After a previous thorough and futile search for Gambusia had been made in southern New Jersey, Seal in 1905 planted 10,000 individuals. Apparently this attempt at colonization failed unless the Gambusia found by Fowler (1907) in small creeks emptying into Delaware Bay in Cape May County in 1907 were derived therefrom, which seems improbable. At the time of Fowler's discovery they were abundant in small ditches and creeks in the vicinity of Goshen. In July, 1918, the author visited this locality with Mr. Fowler in the hope of securing a supply for experimentation. Not the slightest trace of the top minnow could be found anywhere in the neighborhood, though Fundulus was very abundant in the very creeks and ditches from which the Gambusia had been taken. The previous winter had been a very severe one, and it was learned from the natives that all of these creeks had been frozen to the bottom. The resulting mortality among many of the animals inhabiting these waters, notably the blue crabs, was reported to have been very heavy. It was therefore concluded that the Gambusia had been exterminated by the cold. It seems clear that the established natural range of Gambusia does not extend north of Delaware. Some inquiries were made to determine whether this northern limit fluctuates with the degree of severity of the winters, but no reliable data were secured.

Gambusia is so eminently fitted as a factor in the biological control of anopheline mosquitoes within its natural range that the desirability of extending the area of its usefulness northward seems unquestioned. The determination of a means of accomplishing this is of some importance. A few experiments have therefore been tried. On August 21, 1918, 200 Gambusia received through the Bureau of Fisheries was introduced into a small ornamental pond (fig. 14) on the campus of the University of Pennsylvania from which all other fishes had been removed previously. Their increase was so rapid that by the middle of September many young could be seen everywhere about the edges of the pond which was kept nearly free from mosquito breeding for the remainder of the season. The following winter was a very mild one, and there was a light covering of ice on the pond for only two or three weeks. During the warm weather of Febru-

ary and March a close watch was kept for Gambusia, but none was seen. Early in April boys displaced the screen which had been placed across a trench connecting this pond with a larger one and admitted some sunfishes. On discovering this the small pond was immediately seined and the intruders removed. Only a solitary female Gambusia was found on April 12. There is some uncertainty whether the others were eaten by the sunfishes, but no traces of any were found in the digestive tracts of the latter, and in view of Hildebrand's observation of the successful association of the two this seems improbable. Small plantings in two ponds at Media and single fish placed in rain barrels had likewise disappeared, except that a dead fish was found in one of the latter. A brood stock of several hundred kept in an aquarium tank in the University of Pennsylvania vivarium and fed first on *Culex pipiens* larvæ and later on ground boiled liver and living Daphnia not only survived but increased in number.

On May 26, 1919, after repeated thorough seining which yielded no additional Gambusia or sunfishes, and the temperature of the water being 64° F., 40 female and 12 male top minnows from the reserve stock were introduced. At this time the water was thick with entomostracans, chiefly Daphnia, upon which the Gambusia immediately began feeding eagerly. While these lasted the Gambusia partially neglected the mosquitoes, and moderate breeding continued at the rate of 3 to 4 per dipper in easily accessible places and at nearly 10 times that rate in protected places. By June 5 the swarm of entomostracans had nearly disappeared and the Gambusia were searching among the plants and close to shore for food. Several small groups of young were already seen. Mosquito larvæ were present in exposed places at the rate of 2 to every 3 samples. In the fine screen check pen the numbers ran 8 to 15 Culex and 1 to 6 Anopheles per sample. On June 18 Gambusia were much in evidence all over the pond and mosquito breeding had fallen to only 4 Culex larvæ in 30 dippers taken all round the border of the pond, including thick vegetation, while in the check pen the average was 4.8 per dipper, about 20 per cent being Anopheles.

On June 30 conditions were the same, except that the rate of breeding in the check pen had risen to an average of 14.3. During July the Gambusia increased in number astonishingly. On July 23 they swarmed everywhere in both the small and larger ponds, into which latter they had escaped through flooding of the ponds. A remarkable succession of heavy rains during midsummer caused the ponds to overflow several times. The surplus water poured down a walk and over the grounds, leaving short-lived pools here and there when the rain ceased. From a single one of these 301 Gambusia were recovered and in addition many dead were seen on the ground. When it is considered that these were only a small part of those that escaped and that the fishes still swarmed in both of the ponds it can readily be seen that the 52 fishes introduced on May 26 must have increased to several thousand in the course of only three months. This is quite consistent with what is known of the number and size of the broods and early maturity of this fish. With the exception of a few dragonfly and Dytiscus larvæ which were abundantly supplied with other food they had no enemies whatever in the small pond. They continued to increase through-

out August and September and nearly eliminated mosquito breeding in both ponds except in the fine wire check pen. In October a reserve stock for the winter was secured and kept as before. The winter of 1919-20 was long-continued and severe. These ponds were frozen over about Thanksgiving Day and remained locked in ice, which reached a thickness of 18 inches, until March 23, 1920.

During the last week of March and during April repeated searches failed to disclose any Gambusia, and as only five sunfishes were seined in the small pond their complete disappearance can be attributed only to their inability to survive the winter. On April 22, 1920, the water temperature being 60° F., 23 females and 13 males were introduced into the small pond. By the middle of May young began to appear and rapidly increased in number. On August 2 they had become very numerous and young, one-half to three-fourths inch long, were everywhere and very active. Mosquito larvæ which were widely distributed in this pond in moderate numbers early in the season had now totally disappeared. As no other fishes were present in the pond their disappearance may be safely attributed to the Gambusia, though stomach examinations always gave negative evidence. On October 29 the winter's brood stock of 300 was removed to the vivarium. The winter of 1920–21 was one of the mildest ever recorded at Philadelphia. Only three times did ice form on the pond, and at no time did it remain as long as eight days and only then exceeded three-fourths inch in thickness. During most of the winter the water was open. Nevertheless not a single Gambusia could be found in the spring of 1921.

Similar experiments were tried at Broomall's dam near Media. Here several small ponds about 12 to 15 feet square, separated by narrow earth embankments and cut off from the main pond by similar embankments, were arranged. These were filled partly by seepage from the pond and partly by a small spring and were planted with aquatics and densely grown with vegetation around the margins, especially saw grass, spearmint, and tear thumb, and at times are the most prolific source of Anopheles of which the writer knows in this neighborhood. Both the shallows of the main pond and certain of these small ones were planted with Gambusia with the same result, so far as rapid increase and winter killing is concerned, as described above. In one experiment eight females and three males were placed in a pond about 12 feet square and 2 feet deep on June 9. At that time there was light breeding of Culex and no Anopheles. On August 27 Gambusia was plentiful, and 10 samples of water yielded 1 *Culex pipiens* larva and 1 pupa and 2 Anopheles larvæ, while an exactly similar contiguous pool without Gambusia yielded 22 Culex and 12 Anopheles. On October 8 the first pool yielded in 20 samples 1 Anopheles and no Culex, and the second, 20 larvæ and 1 pupa of Culex and 10 larvæ and 2 pupæ of Anopheles. Gambusia was then present in abundance in the first.

A single Gambusia placed in a rain-water barrel was found to keep it clear of *Culex pipiens* and *Aedes triseriatus*, which also breeds in rain barrels at the author's home, but they did no better than small goldfish or sunfish and had the disadvantage that owing to their small size and top-swimming habits they were washed out in heavy rains or if the barrels were covered were injured on the top. This

was easily overcome by making a screened overflow a couple of inches below the top of the barrel.

The above account shows that Gambusia may be successfully employed north of its natural range in controlling mosquitoes in water gardens and other small ponds heavily grown to vegetation. A few specimens introduced in the early spring will have increased to effective numbers by the time mosquito and especially Anopheles breeding becomes active. The water temperature of 60° F. for planting was selected arbitrarily, and it may be that they could be planted successfully at lower temperatures, but it is safer to avoid too great a shock. The greater number of individuals should be females, but it is desirable to have some males, though as the species is viviparous it may be that the first brood from pregnant females would supply this need. Of course the larger the number introduced the sooner will effective control be established, but under favorable conditions they increase with astonishing rapidity. It is also important in these small ponds that predacious fishes and other enemies should be removed as thoroughly as possible. The adults also devour the young, especially when other food is scarce. For this reason the population in a pond will in time become self-limiting. To postpone this as long as possible it would be desirable at the beginning of the season either to isolate the breeding fishes in a pen of one-fourth inch cellar window screen through which the young may escape or to provide retreats for the young. As maximum destruction of mosquitoes depends upon the hunger of the fishes they should not be artificially fed.

After a supply of Gambusia is once secured it is a simple matter to maintain it by removing in the fall to a greenhouse or other suitable place indoors a sufficient number to provide brood fish for restocking in the spring. They are easily caught with a dip net or minnow seine, and several hundred may be kept in an ordinary tub in which are a few sprays of Elodea or other water plant. They may be fed with fish foods, yolks of hard-boiled eggs, or boiled liver ground fine, or still better with mosquito larvæ or entomostracans. As hundreds of Anopheles-breeding ornamental ponds are found in country places, parks, and the suburbs of every large city aquarium dealers might find a profitable business in furnishing Gambusia for stocking them.

Another type of mosquito-breeding habitat, where Gambusia would undoubtedly prove extremely valuable, is found in the very shallow plant-choked waters about the heads of many ponds and in swampy areas generally. But such areas are often too large for annual stocking. The planting of a permanent self-perpetuating stock only would suffice. Up to the present such stocking in the latitude of Philadelphia has failed. Just why Gambusia will not live over winter is not clear. The winter of 1920–21 was no more severe than those to which the top minnow is frequently exposed within its natural range, yet in four ponds in which they thrived during the preceding summer not a single one appears to have survived. In an attempt to solve this second problem it is proposed to search the northern border of this fish's range for a cold-resistant race or to attempt the isolation of such a race by selection and possibly by hybridization.

BLUE-SPOTTED SUNFISHES (Enneacanthus gloriosus and E. obesus).

The two species of Enneacanthus (*gloriosus* and *obesus*) which together are distributed throughout the Atlantic coastal watershed from Massachusetts to Florida are so closely similar specifically and in habits that the author is not sure that they were always distinguished in his limited field observations which were made chiefly in Palisades Interstate Park and near Bristol, Pa. However, most of them were certainly *Enneacanthus gloriosus*.

Of all the sunfishes found in this region the small size and vegetation-haunting habits of these species would seem to recommend them most highly as mosquito destroyers. Seal (1908, p. 352) considers them one of the most valuable fishes for this purpose, and the author's observations lend support to his view.

Table 5 (p. 37) records the contents of stomachs of 36 specimens taken in Car Pond and Cedar Lake, N. Y., during July and August, 1919. It is noteworthy that the food was almost exclusively insects and crustaceans. There were no mollusks and no worms and mere traces in a few cases of algæ and other plant remains. Larvæ of *Culex pipiens* and *Aedes sylvestris* (in two cases in large numbers) were found in 10 stomachs, a pupa of *Culex pipiens* in each of 2, and eggs or egg boats in 4, the whole comprising about 6 per cent of the entire stomach contents. Chironomid larvæ, together with a few syrphids and other Diptera, constituted about 23 per cent, all other insects 35 per cent, crustaceans, chiefly minute forms, 30 per cent, leaving 6 per cent for water mites, spiders, algæ and other plants, and miscellaneous objects. In one case the entire contents consisted of amphipods; in another 70 per cent was Cyclops.

Examples of *Enneacanthus gloriosus* taken in a sluggish, weedy creek near Bristol, Pa., were used chiefly in laboratory feeding experiments in which it was determined that when confined in aquarium tanks they fed freely upon Culex larvæ and egg boats which were often detected even among masses of floating Elodea, Ceratophyllum, Lemna, and other water plants.

A number of observations and field experiments were made at Palisades Interstate Park. In shallow plant-grown waters in Car Pond a few blue-spotted sunfishes (Table 5, No. 2356a)—some of which may have been *Enneacanthus obesus*—were taken along with common sunfishes. None of these was found to contain mosquito remains. Indeed, their stomachs contained very little food of any kind, and it may be that owing to the presence of great numbers of the more aggressive and pugnacious common sunfish they were prevented from feeding freely.

The most favorable conditions for studying this species were found in Cedar Lake, particularly at one point (M), to which attention was directed by Prof. Hankinson. This was an area of shallow water (fig. 9) sheltered behind an island and thickly grown with aquatic vegetation, chiefly Myriophyllum and Utricularia, together with patches of Sagittaria and flowering rush. The shore here was swampy with a flooded area about 20 by 30 feet cut off from the lake partly by projecting banks and partly by masses of vegetation and brush (fig. 10). There was also a number of pools of various sizes isolated by rocks. In the lake itself at this point *Enneacanthus gloriosus* was found to be by far the most abundant fish, though the

TABLE 5.—FOOD OF 36 BLUE-SPOTTED SUNFISHES (ENNEACANTHUS GLORIOSUS).

Field number.	Locality and station.	Date.	Specimens reported. Length in mm.	Specimens reported. Number.	Mosquitoes.[1]	Other insects.	Crustaceans.	Other animals.	Plants.	Remarks.
2345	Cedar Lake, Palisades Park. M 1.	July 15, 1919	40–52	10	3, 7+. Culex pipiens larvæ, 3; Aedes sylvestris larva, 1; Culex pipiens egg boats, 4+.	Chironomid larvæ in all, pupae in 3; many other insects, chiefly larvæ.	Entomostracans of many kinds in all, often in large quantity.	....	Small quantity of algæ.	Stomachs full.
2356a	Car Pond, Palisades Park, Globe Camp bay. J.	July 24, 1919	52–64	5	....	Chironomid and other dipterous larvæ, mayfly and dragonfly nymphs and other insects.	Entomostracans and amphipods.	Water mites	....	Little in stomachs.
2360c	Car Pond, Palisades Park, Brooklyn Industrial cove. D.	.....do.....	54–72	2	1, 2. Culex pipiens larvæ.	Many chironomid larvæ, 1 stone-fly larva.	....	1 spider.....	....	One stomach well filled, the other not.
2365a, c	Cedar Lake, same as 2345. M 1.	July 31, 1919	22–50	6	1, 1. Aedes sylvestris larva.	Several chironomid and 2 mayfly larvæ, 1 unknown larva.	Many entomostracans.	....	Fragments of leaves.	
2368	Cedar Lake; from pen M.	Aug. 4, 1919	42–48	2	....	....	Entirely copepods and egg masses.	....	....	These were from a lot of fishes kept in a pen for stocking detached pools.
2372	Cedar Lake, from pen M 3.	Aug. 11, 1919	40–43	2	2, 16+. Culex pipiens, larvæ, 10, pupa, 1, egg boat, several; Aedes, sylvestris larvæ, 6.	....	Cyclops and Daphnia about 60 per cent.	....	Lemna, Confervæ and diatoms about 12 per cent.	Stomachs well filled.
2376	.....do............	Aug. 21, 1919	51–70	7	3, 5. Culex pipiens larva, 1, pupæ, many; Culex bristles.	Chironomid larvæ, syrphid larvæ and imagos.	Copepods and other entomostracans principal food.	....	....	Fish remaining in pen at close of experiment.
2377c	Car Pond, Palisades Park, Brooklyn Industrial cove. D.	Aug. 23, 1919	30–36	2	....	Chironomid and unknown larvæ.	One largely copepods, one entirely amphipods.	....	....	Little in stomachs.

[1] The first numeral in this column gives the number of individuals in which remains of mosquitoes were detected; the second numeral, the total number of mosquito stages counted.

seine yielded also roach, catfish, common sunfish, and yellow perch, all of small size and in small numbers. Whirligig beetles (Gyrinus) were abundant in the quiet sheltered waters. Close to the shore, among the vegetation, egg boats of *Culex pipiens* and a few newly hatched larvæ, both of this species and of *Aedes sylvestris*, were found in considerable numbers on June 14 and subsequent dates, but not a single advanced larva or pupa was found in the lake at this point. Eggs and young larvæ of mosquitoes were found in 30 per cent of the stomachs of blue-spotted sunfish taken here on July 15 (Table 5, No. 2345, p. 37)—strong evidence of its importance as a factor in preventing the maturation of mosquitoes in these plant-choked waters.

The pools cut off from the lake waters and inaccessible to fishes and in which no fishes could be found were, on the other hand, sources of prolific breeding. In these and especially in the rock pools not only were egg boats and young larvæ found in great numbers, but there were all stages of larvæ as well as pupæ of both *Culex pipiens and Aedes sylvestris*, together with many cast pupal skins, showing that development had been completed. In one of these pools (fig. 11), measuring 6 by 2 feet and separated from the lake by a barrier less than a foot wide, formed partly by a rock and partly by the root of a tree, and in which Utricularia was growing in abundance, 12 blue-spotted sunfishes were placed on July 15. At that time culicine breeding was so dense that the larvæ could not be accurately counted in the dipper, but every sample contained 50 and more larvæ of all sizes, together with pupæ of both species, besides frequent egg boats of *Culex pipiens.* Ten days later, on July 25, the rate of breeding in this pool had been reduced to an average of 6, and on August 7 to 4.6 per dipper for 20 samples, while neighboring similar pools in which no fishes had been placed showed no diminution in the rate. During the interval exceptionally heavy and frequent rains had raised the level of water in the lake, and it is possible that the barrier had been slightly submerged, though there was no evidence of this. Owing to the irregular contour of the bottom and sides of the pool it was found impossible to secure any of the sunfishes for stomach examinations.

To overcome the latter difficulty, a mosquito screen box, open above, was placed in a neighboring similar pool (M 3), where the rate of breeding had been maintained, care being taken that conditions within and without the screen both as to plants and the density of mosquito breeding were exactly similar. On August 7, after allowing the screen to remain undisturbed for a week, 10 small blue-spotted sunfishes were placed therein. On this date the number of mosquito larvæ (mostly half grown) both within and without the screen averaged 30+ per sample. On August 11 the average within the screen was 8.1, outside it was 22. The stomachs of two (Table 5, No. 2372) of the fish taken from the screen on this date contained, besides a large number of Cyclops and Daphnia (about 60 per cent) and plants, consisting of Lemna, filamentous algæ, and diatoms (about 12 per cent), no less than 10 larvæ, 1 pupa, and several disintegrated egg boats of *Culex pipiens* and 6 larvæ of *Aedes sylvestris.*

TABLE 6.—FOOD OF 26 LONG-EARED SUNFISHES (LEPOMIS AURITUS).

Field number.	Locality and station.	Date.	Specimens reported.		Mosquitoes.[1]	Other insects.	Crustaceans.	Mollusks.	Other animals.	Plants.	Remarks.
			Length in mm.	Number.							
18731b	Philadelphia, Pa., University of Pennsylvania botanical garden pond.	July 31, 1918	63–66	10	1, 1. Culex pipiens larva.	Almost entirely chironomid larvæ with a few other insects.	Very few ostracods.	....	A few oligochætes.	Diatoms......	Stomachs packed full of chironomid larvæ.
18803	.....do..........	Aug. 3, 1918	36–60	5	....	About 80 per cent chironomid larvæ, 1 adult fly.	A few entomostracans.	....	Oligochætes.	Roots of Lemna with attached diatoms.	
18813d	.....do..........	Aug. 13, 1918	63–92	4	1, 2. Culex pipiens larvæ.	Few chironomid larvæ; many ants and other terrestrial insects of great variety.	Asellus in one..	....	.....do......	Diatoms......	Stomachs filled chiefly with terrestrial insects.
19412b	.....do..........	Apr. 12, 1919	60–64	4	....	1 large chironomid larva and a large beetle.	....	....	An entire earthworm and some unrecognized matter.	Spirogyra and mass of vegetable débris.	Little in stomachs.
19516	.....do..........	May 16, 1919	87	3	....	A few chironomid larvæ and many flying insects.	A few Cyclops, 1 large Asellus.	....	Tadpoles....	....	

[1] The first numeral in this column gives the number of individuals in which remains of mosquitoes were detected; the second numeral, the total number of mosquito stages counted.

On August 21 breeding in this pool had fallen to an average of $3\frac{3}{5}$ per sample, while inside the screen only one larva was found. Of the seven fishes (Table 5, No. 2376, p. 37) remaining within the screen on this date three contained Culex larvæ and one a pupa, the remaining contents being chiefly copepods with a few insects. Other experiments gave more or less similar results but offer only cumulative evidence or include some element of doubt. Enough is known of the blue-spotted sunfishes to recommend placing them on the list of species for stocking plant-grown ponds and streams.

LONG-EARED SUNFISH (Lepomis auritus).

The long-eared or red-bellied sunfish is abundant throughout all of the Atlantic and Gulf Coast States from Maine to the mouth of the Mississippi River. Thriving best in the larger streams and ponds it is less likely to come into contact with mosquito breeding than are other species. In small ponds it is almost always associated with the much more abundant common sunfish. For these reasons it was given little detailed attention. In only two cases were any mosquito larvæ found in the stomachs, and little specific evidence of the value of this species as a mosquito discourager can be offered. Nevertheless, the young frequent the shallows along with those of the common sunfish, and it is probable that they will eat mosquito larvæ under similar circumstances. In stocking a pond it seems desirable that the two species should be introduced together, inasmuch as it is probable that a given body of water would maintain a larger number of the two combined than of the common sunfish alone. For food see Table 6, page 39.

COMMON SUNFISH (Eupomotis gibbosus).

From Maine the native waters of the common sunfish or pumpkin seed extend southward to Florida and westward to Minnesota. It is, perhaps, the most widely and best known of all of our fresh-water fishes. While absent from few bodies of water of any description (along the Atlantic coast it even meets the oyster in brackish waters), the species is especially abundant in clear brooks, ponds, and lakes. In small ponds it is often present in enormous numbers and becomes dwarfed, probably owing in part to the limitation of the food supply. Under such conditions mosquitoes are rarely found breeding, even where there is a fairly dense growth of vegetation.

This last observation, together with its promising characteristics—namely, its wide distribution, abundance, fecundity, adaptability, hardiness and instinctive aggressiveness, alertness and curiosity—led the author to study this fish more extensively than any other, especially as the statements of previous writers regarding its anti-mosquito value varied greatly. Seal (*in* Smith, 1904, p. 108) gives it a leading place among native fresh-water fishes, while others, as Hildebrand (1919, p. 15) consider it of very doubtful value. As will be seen, the author's results show that these conflicting opinions can be harmonized and on the whole are at least confirmatory of the high value placed upon it by Seal.

Previous studies of the food of the common sunfish have dealt almost exclusively with the adults. Pearse (1918, p. 260) reports

toad eggs, larval, pupal and adult insects, amphipods, crayfishes, leeches, snails, sponges, and algæ and other plants, and continues in this summary:

The food of the pumpkin seed was made up of insects (22.1 per cent), large Crustacea (10.3 per cent), snails (25.8 per cent), plants (25.5 per cent), and other things. Forbes and Richardson (1908) found that more than half the food of the fish they examined was mollusks; the rest was amphipods, isopods, and insects. Hankinson (1908) reported midge larvæ, may-fly nymphs, crayfishes, amphipods, snails, leeches, and caddis-fly larvæ. Reighard (1915) found snails, insect larvæ, and Chara. Insects formed the chief food of those fish examined by Baker (1916).

In the course of this investigation 360 stomachs of the common sunfish were examined. All but 30 of these were of young or small fishes, as it soon became evident that these and not the adults frequented the extreme margins of ponds and similar situations where mosquitoes are likely to oviposit. Table 7 (p. 42) records the summarized stomach contents of 224 examples of fishes measuring from 18 to 97 mm. long, the great majority being under 80 mm. The grand summary gives as food: Mosquitoes in all stages, 9 per cent; chironomid larvæ and pupæ with some other Diptera, 33 per cent; all other insects, 14 per cent; crustaceans, chiefly entomostracans of all kinds, 18 per cent; mollusks, 7 per cent; vertebrates, 4 per cent; all other animal matter, 6 per cent; algæ and other plants, 5 per cent; and silt and débris, 4 per cent. The great diversity and richness of the dietary are only partially apparent, however, and it would seem that anything that is edible and obtainable is eaten.

The principal contents of individual stomachs or of uniform lots of stomachs differed greatly. In many cases they were chiefly or solely chironomid larvæ, in others Entomostraca, sometimes purely a single species of Cyclops or Daphnia, in a few cases dragonfly or mayfly nymphs or the larvæ and pupæ of culicine mosquitoes, or amphipods, isopods, tadpoles, or annelids, and in one case goldfish eggs. Adult fishes were found with the stomachs packed with grasshoppers or 17-year cicadas or dragonfly nymphs. There is great variation with age, season, and locality. The young conspicuously subsist more on entomostracans and small insect larvæ, the adults on the larger insects, crustaceans, snails, and leeches. In the spring mayflies and lamellicorn beetles will be prominent, in the fall grasshoppers and crickets. In brooks caddis-fly, stone-fly, and crane-fly larvæ with crayfishes will often dominate; in ponds, chironomid larvæ; and in sluggish plant-grown creeks and rivers, snails. Propinquity and abundance appear to be of even more importance than choice in determining what is eaten, though the latter is undoubtedly a factor when not overcome by the stronger stimulus of nearness and bigness.

In correspondence with the abundance, ubiquity, and importance for the investigation of this species observations were made over a wide extent of territory and under a variety of conditions. The principal experiments were made near Philadelphia and in Palisades Park.

In the first place abundant confirmation was found of the statement made by Seal and Smith that "this is undoubtedly the most useful species of sunfish as a destroyer of mosquito larvæ." Smith again states (1904, p. 108) that it "keeps the ditches and streams in cranberry bogs free from wrigglers." It may be added with reser-

TABLE 7.—FOOD OF 224 COMMON SUNFISHES (EUPOMOTIS GIBBOSUS).

Field number.	Locality and station.	Date.	Specimens reported.		Mosquitoes.[1]	Other insects.	Crustaceans.	Mollusks.	Other animals.	Plants.	Remarks.
			Length in mm.	Number.							
18515a	Philadelphia, Pa., University of Pennsylvania botanical garden pond. C.	May 15, 1918	51–57	2	1, 1. Culex pipiens larva.	Chironomid larvæ, several; adult fly, 1.	Entomostracans, few.	....	23 goldfish eggs in one.	Fragments half filling stomach.	Much flocculent matter undetermined.
18527 a, b.	....do....	May 27, 1918	45–92	11	1, 1. Culex pipiens pupa.	Chironomid larvæ, few to many; adult flies, several; mayfly, 1; fragments.	....do....	Snails, 2....	Unrecognized matter.	Fibers.......	
18615a	....do....	June 15, 1918	48–60	5	....	Chironomid larvæ, in tubes 20–80 per cent; mayfly nymphs, several; other fragments.	Cladocera and other entomostracans.	....do....	Mites and worms.	Filamentous algæ, hairs and rootlets.	Stomachs mostly well filled.
18708d	....do....	July 8, 1918	44–56	4	....	Chironomid larvæ, 20–25 per cent; plant lice, adult flies, and 1 beetle.	Entomostracans, 50–70 per cent.	....	....	Filamentous algæ and roots.	
18731b	....do....	July 31, 1918	38–66	9	....	Chironomid larvæ, sometimes exclusively; plant lice, few.	Entomostracans, very few.	....	....	....	Stomachs packed full.
18813 a, c.	....do....	Aug. 13, 1918	38–63	10	2, 6. Culex pipiens larvæ.	Chironomid larvæ, 40–60 per cent; other fly larvæ; mayflies.	Entomostracans, about 20 per cent.	....	Mites, protozoans.	Lemna and other plants, diatoms.	
18820d	....do....	Aug. 20, 1918	40–75	10	5, 19. Culex pipiens larvæ, one 50 mm. contained 9, the bulk of contents.	Chironomid larvæ, about 25 per cent; many imago flies, grasshoppers, and some unknown larvæ.	....do....	....	Protozoans..	Lemna......	

19412a	.....do..........	Apr. 12, 1919	36–66	7	....	Chironomid eggs and larvæ; many other insects.	Cyclops exclusively in 2; entmostracans, in others.	....	Tadpoles in one, protozoans, mites.	Desmids, diatoms, Confervæ.	No mosquitoes breeding.
19516a	.....do..........	May 16, 1919	66–87	8	2, 3. Culex pipiens larvæ, 2; Anophiles larva, 1.	Many chironomid larvæ; Dixa and other dipterous larvæ; mayfly and dragonfly nymphs; imago beetles and flies.	Entomostracans from 0–90 per cent.	....	Tadpoles in 5, in one 90 per cent; leech and oligochætes, mites.	Vegetable fiber and débris, diatoms, Confervæ	
19524 c, d.	.....do..........	May 24, 1919	51–77	5	2, 2. Culex pipiens larvæ, 1; pupa, 1.	Some chironomid, mayfly, dragonfly, and other larvæ; adult Diptera.	Entomostracans 50 per cent; Asellus.	....	Protozoa and unrecognized matter; earthworm, small fish.	Filamentous algæ.	
19611 c, e.	.....do..........	June 11, 1919	63–97	7	1, 1. Culex pupa...	Stomachs nearly filled with chironomid larvæ.	Entomostracans, some.	Several snails.	Protozoa....	....	
19721 a, d.	.....do..........	July 21, 1919	36–60	9	....	Chironomid larvæ, great numbers, exclusively in some; many plant lice, few other insects.	Entomostracans about 20 per cent.	....	....	....	Stomachs full.
19806b	.....do..........	Aug. 16, 1919	36–50	15	....	Exclusively chironomid larvæ 85 per cent and unknown fly larva 15 per cent.	....	....	....	....	Do.
19815 a, e.	.....do..........	Aug. 15, 1919	39–72	15	3, 8. Culex pipiens larvæ.	Chironomid larvæ 15–40 per cent; larvæ of several kinds, imago flies, grasshoppers.	Entomostracans about 20 per cent.	....	Mites, protozoans.	Lemna........	Stomachs moderately to well filled.
19916a	.....do..........	Sept. 16, 1919	19–35	3	....	Chironomid larvæ, exclusively in one.	....	Large snail in another.	....	....	Stomachs one-half to well filled.
18816d	Essington, Pa., Westinghouse sluice pond.	Aug 16, 1918	29–66	6	1, 1. Culex larva...	Chironomid larvæ, few; dragonfly nymphs; imago Diptera.	Entomostracans very few.	....	Protozoans, naiid worms.	Nearly half of contents plant débris and algæ.	Much silt and slime.
18905	Essex County, N. J., Meyers' fishpond.	Sept. 5, 1918	24–60	7	1, 2. Two eggs closely resembling Aedes sylvestris.	Chironomid larvæ, mayflies, Eristalis, water beetles, and other insects.	Ostracods in large numbers.	Snails.......	Mites, Bryozoans.	A few algæ filaments and plant hairs.	The only case of solitary mosquito eggs.

[1] The first numeral in this column gives the number of individuals in which remains of mosquitoes were detected; the second numeral, the total number of mosquito stages counted.

TABLE 7.—FOOD OF 224 COMMON SUNFISHES (EUPOMOTIS GIBBOSUS)—Continued.

Field number.	Locality and station.	Date.	Specimens reported.		Mosquitoes.	Other insects.	Crustaceans.	Mollusks.	Other animals.	Plants.	Remarks.
			Length in mm.	Number.							
20813g	Kenvil, N. J., Hercules Co. plant, Duck Pond. 10.	Aug. 13, 1920	26–57	13	....	Chironomid larvæ 15–80+ per cent; dragonfly and mayfly nymphs.	Entomostracans and Asellus.	....	....	Small amount of Confervæ and plant tissue.	Stomachs full.
2331	Car Pond, Palisades Park, Brooklyn Industrial cove. D 1.	July 11, 1919	60–108	10	4, 5. Larvæ of Culex pipiens and Aedes sylvestris.	Many chironomid larvæ and 1 pupa; dragonfly, mayfly, and Dytiscus larvæ, and other insects.	Entomostracans, isopods, and amphipods.	Planorbis, Pisidium.	....	Small amount of algæ and vascular plants.	
2360 a, b.	.....do..........	July 24, 1919	70–81	7	3, 5+. Culex larvæ 3+; pupæ, 2.	Great number of chironomid, caddisfly and other larvæ; insect eggs.	Entomostracans few.	Planorbis in all.	....	....	
2364b	.....do..........	July 30, 1919	71–78	3	1, 3. Full-grown Culex pipiens larvæ.	Chironomid larvæ, many; large syrphid pupa, 1; mayfly and other larvæ.	Copepods and amphipods, few.	Planorbis...	....	Rootlets and other remains.	
2377a	.....do..........	Aug. 23, 1919	21–39	8	1, 1. Culex larva...	Chironomid larvæ, few.	Chiefly entomostracans.	....	....	....	Young of year. Fry.
2377b	.....do..........	.....do.......	73–77	5	1, 1. Culex pipiens larva..........	Chironomid larvæ, almost exclusively, with a few other larvæ.	Entomostracans, amphipods.	Planorbis...	1 mite......	....	Yearlings.
2335	Car Pond, Palisades Park, head of Globe Camp bay. J 3.	July 12, 1919	61–85	10	6, 9+. Culex pipiens and Aedes, sylvestris larvæ, 8+; Culex pipiens pupa, 1.	Chironomid, dragonfly, mayfly, stone-fly and other larvæ; fragments of imagos and eggs.	Entomostracans of much variety.	Planorbis, Ancylus, Pisidium.	Mites, protozoans.	Algæ and plant débris.	Individuals differ much in percentages.
2356b	.....do..........	July 24, 1919	63–77	5	....	Chironomid larvæ in great numbers.	Entomostracans, isopods, amphipods.	A few Planorbis, Pisidium.	....	Traces.......	

2356d	Car Pond, Palisades Park, head of Globe Camp bay. J 3. but close to opened pools.	....do........	20–28	10	6, 14+. Culex pipiens and Aedes sylvestris larvæ 10+; pupa, 1; eggs, 3.	Chironomid larvæ, in moderate numbers; Dixa, Dytiscus.	Entomostraca, mostly Cyclops, amphipods.	....	....	....	Fry.
2357b	Car Pond, Palisades Park, head of Globe Camp bay, actually in one opened pool. J 4.	....do........	18–28	4	4, 15. All positively identified Culex pipiens larvæ and 1 pupa.	Chironomid larvæ, few in two.	Entomostracans in all.	....	....	....	Do.
2362b	Same as 2335. J 3.	July 30, 1919	25–30	10	3, 3. Culex pipiens larvæ, 2; pupa, 1.	Chironomid larvæ in moderate numbers, a few other larvæ.	Entomostracans principal food.	....	....	A little Spirogyra in two.	Do.
2378a	....do..........	Aug. 23, 1919	32	3	1, several. Culex pipiens eggs and larvæ; bristles of a culicine larva.	....	Entomostracans almost exclusively.	....	1 mite........	....	Do.
2378b	....do..........	....do........	71–78	3	1, 3. Culex pipiens larvæ, full-grown, intact.	Chironomid larvæ, many, mayfly and other larvæ; Syrphid pupa.	Copepods few.	Planorbis, several.	....	Rootlets.......	
2353b	Car Pond, Palisades Park, head of Globe Camp bay, opened pool. J 6.	July 15, 1919	68, 70	2	1, several. Culex larvæ, mouth brushes and bristles.	Chironomid, mayfly and Tanypus larvæ.	Entomostracans, many.	....	1 small tadpole.	Spirogyra, desmids.	
2359a	....do..........	July 24, 1919	77, 81	2	2, 2. Adult male Culex pipiens.	Chiefly chironomid, caddis-fly, and other larvæ; insect eggs.	....	....	Difflugia and other protozoans.	Bits of leaves, desmids, Confervæ.	Much débris and ooze.
2363b	....do..........	July 30, 1919	72–90	6	2, 3. Culex pipiens siphon and mouth brushes, many Culex bristles.	Chiefly (1 exclusively) chironomid larvæ and tubes, 1 pupa, 2 adult midges; mayfly nymphs.	A few copepods and ostracods.	....	....	....	Do.

vations that will appear later that it is equally effective in the numerous ponds, dams, lakes, and other bodies of water in which it is abundant.

In Broomall's Dam, near Media, Pa., most of the shore is clean and nearly free from dense growths of vegetation. Frequent examinations, especially in the early morning and evening, invariably found large numbers of small sunfish of this species exploring and feeding to the very edge of the water. At one point is a shallow area which was covered by a rather dense growth of saw grass, tearthumb, Sagittaria, and other plants. Much light drift material had collected here and blocked a zone about 40 yards long and from 8 to 2 feet wide. Within this area fishes were seldom seen. Another area at the inlet was silted up and obstructed by stranded logs, brush, etc., brought down by floods, so that fishes could not enter freely. At another point a large flat-bottomed scow was so stranded in a shallow cove that a pool behind it was completely cut off from the lake.

Throughout the three summers covered by this investigation the history of this pond was followed closely. Except for an occasional egg boat or larva sheltered behind an obstruction practically no breeding was ever detected round the open shores of the pond frequented by the sunfishes, but in each of the obstructed areas referred to breeding continued just as long as they were barred to the fishes. In the first mentioned there was always light breeding of *Culex pipiens*, together with a few Anopheles larvæ. In the other two, as well as within the boat itself, there was heavy breeding of *Culex pipiens* only. When the boat was moved and the other areas opened, sunfishes immediately entered and devoured the larvæ and pupæ with avidity. In the plant-grown area breeding was never entirely stopped except during a period of about six weeks in 1919. A few larvæ of both genera could always be found behind shelters, and in little shut-off pockets breeding was sometimes dense.

During the summer of 1919, while some repairs were being made, the level of the water was lowered sufficiently to entirely drain this area. Under these conditions the fishes could penetrate to every part of the water, and while they were deprived of the shelter of the plants no mosquito larvæ whatever were found in any part of this pond. This was in marked contrast to conditions in some check pens constructed on one side of the pond and separated from its waters by earth embankments not exceeding 2 feet in thickness. In these the breeding of *Culex pipiens* would often run up to 30+ per dipper and some Anopheles could always be found. When, however, sunfishes were introduced into one of these pens the number of larvæ quickly fell to one-third per dipper.

This pond is deep and cold, being fed by springs, and fish food is not overabundant, while sunfishes are very plentiful, so that they are probably chronically hungry, as is indicated by the eagerness with which they will take almost any kind of bait. Not all of the credit for keeping this pond so nearly free from wrigglers should be given to the common sunfishes, for there were also long-eared sunfishes, calico bass, and roach present. Except for the last, however, the common sunfishes were by far the most plentiful, and the area of freedom from mosquitoes corresponded exactly with the observed area of their activities, while it did not agree so closely

with the range of the others. Moreover they were the only species that was actually seen to eat the larvæ and the only one in whose stomachs larvæ were actually found.

On the plant of the Hercules Powder Co., at Kenvil, N. J., is a natural pond of several acres area. This was visited in September, 1918, and thoroughly examined on August 13 and 14, 1920, a time when mosquito breeding was generally at a rather low ebb. Most of the shore of this pond was clean, and while vegetation was often plentiful it was seldom sufficiently dense to form an effective barrier to prying fishes. There were many excellent places for the nesting of sunfishes, and that they had been utilized was shown by the large number of young seen everywhere patrolling the shores to the water's edge. Young roach also were plentiful but showed less of the exploring instinct. Nowhere round these shores, even among the vegetation, were any mosquito larvæ found except at one point, where a heavy log had lodged across the mouth of a small bight and being both deep sunken in the bottom and reaching above the surface formed a complete dam. Behind this in the cut-off pool larvæ of both *Culex pipiens* and Anopheles were found, and this was the only place in the pond that was not open to the fishes and the only one where breeding was detected.

On the other hand, in a near-by swamp where there were no fishes there was abundant breeding of *Culex pipiens* and *Aedes sylvestris*, and immediately across a low narrow railroad embankment was a large pool, except for size, exactly similar to Duck Pond and probably originally part of it and now fed by seepage through the embankment. In this pool there were no fishes of any kind and *Culex pipiens* was breeding everywhere in moderate numbers (3.4 per dipper). The stomach contents of the fishes taken in Duck Pond are shown in Table 7 (No. 20813g, p. 44). The sunfishes contained 40 per cent of chironomid and a few other larvæ, the remainder being entomostracans with a trace of algæ. In the 13 stomachs examined no mosquito remains were found. More than a score of similar instances might be given showing a correlation between the distribution of the common sunfish in particular bodies of water and the absence or paucity of mosquito larvæ, together with their presence in parts of the same waters to which fishes do not penetrate.

The history of mosquito breeding (chiefly *Culex pipiens*) in the larger pond in the University of Pennsylvania botanical gardens illustrates some of the conditions limiting the effectiveness of the common sunfish in relation to mosquito control. This pond (figs. 12, 13, 14) is filled with water lilies and other ornamental plants, but in few places is the growth dense enough to prevent the small sunfishes which occur in great numbers from reaching all parts of the shore line. Besides the common sunfish were some long-eared sunfish in the ratio of about 3 to 1, many large goldfish, and a very few roach. Bullfrogs and tadpoles were very abundant, and there were some predacious beetles and bugs. There were no young goldfishes, as the sunfishes ate their eggs as fast as laid. The sunfishes, however, bred successfully. Many nests were seen, and the young abounded during the summer.

During May and the first half of June, 1918, mosquitoes were flying in considerable numbers (produced by some tubs of water in a

potting shed) and ovipositing. In the pond they made no headway, except within the fine wire check pen and in a gutter, also screened off from the fishes.

By the first week in July these conditions had greatly changed. The vegetation had become much more dense, and masses of Confervæ had collected along the shore. On July 8 mosquito larvæ, mostly in early stages, were found almost everywhere near the shore and in places where the vegetation was heaviest were as numerous as within the check pens. But even large larvæ were found in places fully accessible to the fishes. At this time the water was swarming with Daphnia, and great numbers of plant lice were falling from the leaves of water lilies and other plants. In the bottom mud and on submerged plants chironomid larvæ of several kinds were in very great numbers. Examination of stomachs of sunfishes (Table 7, No. 18708d, p. 42) at this time showed them to be packed full of this abundant and nutritious food to the neglect of mosquito larvæ. During July the numbers of entomostracans and plant lice gradually diminished, but the chironomid larvæ remained plentiful and formed the chief food of the sunfishes.

About the middle of August a reduction was apparent in these also. On August 13 mosquito larvæ were again detected in the stomachs (Table 7, No. 18813a, c), the contents of which became much more varied, indicative of a necessity of covering a wider range in foraging. On August 28 mosquito breeding had been nearly abolished in the pond generally but continued with undiminished activity in the check pens, while some tubs of water nearby were swarming with larvæ. The stomachs of sunfishes (No. 18820d) examined at this time (Aug. 20) contained many young larvæ of mosquitoes; one 2-inch specimen had eaten little else. Later, as the rate of breeding declined, they again disappeared from the stomachs. Until mosquito breeding ceased about the middle of October conditions remained the same. Breeding was negligible, the number of larvæ averaging about 1 in each 4 samples taken in all parts of the pond, while in the check pens the average fell gradually from 13 to 2.3 per sample on October 11, when the last count was made.

In 1919 the first oviposition of *Culex pipiens* in this pond was observed on May 2. The first Culex larvæ were found in stomachs of fishes taken on May 16 (Table 7, No. 19516a). On May 19 light breeding was found in the check pens only. On May 24 the general average in the pond accessible to sunfish was three-fifths larva per sample. Most of these were small *Culex pipiens*, but an occasional Anopheles larva, mostly of large size, was found. In the coarse screen pen the average was nearly 1, and in the fine screen pen between 7 and 8 per dipper, some being nearly full-grown Culex. In the gutter the rate was about the same as the last and a few Culex pupæ and Anopheles larvæ were found.

On June 5 the pond generally yielded one-fourth larva per sample. This rose to 4 to 6 in the coarse screen pen and the densest vegetation, to 20 (mostly first and second stage Culex) in the fine screen pen and to 8 to 15 Culex and 1 to 6 Anopheles in the gutter. Many of the latter were full grown or nearly so. The stomachs of fishes (Table 7, Nos. 19524c, d, and 19611c, e) taken during this period frequently yielded mosquito larvæ. On June 18 these breeding av-

erages were, respectively, 0.25, 3.6, 14, and 5 and on June 30, 2.5, 3, about 20, and 13, respectively. On July 21 they were nearly 3, 4, and 16, there being no record for the gutter, as the water had flowed around the screens.

The next thorough examination was made on August 15. During the interval heavy rains had flooded the ponds and escaped Gambusia as well as young sunfish had penetrated everywhere except the line screen check pen. In correspondence with this there was practically no breeding anywhere except in this pen. In 60 samples taken in all parts of the two ponds no larvæ were found in the small pond, 2 small Culex in the gutter, and 3 in the large pond. How much of this reduction was due to the sunfish and how much to the top minnow could not be determined. Stomach contents of sunfishes (Table 7, p. 43, Nos. 19721a, d; 19806b; and 19815a, e) taken during this period gave results similar to those obtained in 1918, namely, during the period of great abundance of chironomid larvæ and other food in July and early August mosquito larvæ were neglected but reappeared in the food on August 15 as part of a much more varied diet. On later dates, owing probably to the presence of Gambusia and greatly diminished breeding, none were found in the stomachs.

These and similar experiments made on ponds in Delaware County and numerous observations made at other places make it clear that the common sunfish is very effective in keeping culicine breeding in check, except for a period from about the middle of June to early August, during which the great abundance of attractive and easily secured food leads to the neglect of the mosquito larvæ, at that time well protected by the increased vegetation. The fact that this is their breeding season probably also affects this result. Later in the summer they again turn to mosquitoes, as is evidenced both by the diminution in the numbers of the latter and by their presence in the stomachs of the fishes. There is also a parallel effect upon anopheline breeding, but this is far less evident and certain and is not supported by the results of stomach examinations. The very efficient control that was exercised during August and September, in spite of the greater density of the plant growths, is due mainly to the large numbers of young sunfishes which penetrated the vegetation and entered the very shallow waters.

Some of the experiments in Palisades Interstate Park during July and August, 1919, were made on a larger scale and show the positive rôle of this species in mosquito control even more clearly. Of these, two typical experiments in which the common sunfish was the chief actor will be described. The first (D. 1) relates to a little sheltered cove (figs. 6, 7, 8) described on page 21. On the open shore of the lake outside of this area there was no breeding except in detached pools, etc. No fishes were found in the barred area, but outside of it they were numerous. Mud minnows, young roach, long-eared sunfishes, blue-spotted sunfishes, stone catfishes, and especially common sunfishes were seined. Adults of the latter and of the long-eared sunfish were breeding in large numbers along a sandy and gravelly shore here, and 100 nests were counted without exhausting them. No mosquitoes were detected in the stomachs of sunfishes taken on this date (July 5).

On July 10 and 11 the obstructions were removed and most of the choked area (D 1) opened to fishes. On the latter day large numbers of mud minnows and common sunfishes had entered these waters. Most of the latter, which were very numerous, were yearling fish from 2 to 3 inches long. Of the stomachs of 10 examined (Table 7, No. 2331, p. 44) mosquito larvæ were detected in four, the remaining food being of the mixed character found in fishes taken outside of this area and consisting chiefly of chironomid larvæ with some other insects, mollusks, minute crustaceans, and a small amount of plant remains.

The rate of breeding in different parts of this area on July 10 averaged from 16 to 60 per 10 samples at each point, or 32 for the entire area.

On July 15 the rate of breeding had fallen greatly in all places accessible to the fishes but remained undiminished where still barred to them.

The area was next seined on July 24, when large numbers of sunfishes were taken close inshore throughout the experimental area. Of seven (Table 7, No. 2360a, b) examined, mosquito larvæ and pupæ were detected in three, and in one of these were several. The breeding rate had fallen to an average of below 4 for the opened area, while in unaltered checks, natural cut-off pools, and pens it averaged 28, including some pupæ of both *Culex pipiens* and *Aedes sylvestris*.

On July 30 only an occasional mosquito larva could be found in the opened waters while in the checks the rate was undiminished. Of 3 stomachs of sunfishes (Table 7, No. 2364b) taken here which were examined 1 contained 3 *Culex pipiens* larvæ.

On August 23 breeding averaged 1 larva to 5 dippers except in an occasional sheltered spot where egg boats or newly hatched larvæ were found. In the latter case counts ran as high as 6 per dipper. In the checks the averages for each ran from 8 to 20 larvæ and pupæ in addition to many egg boats. On this date, of 13 stomachs (Table 7, Nos. 2377a and 2377b) examined, only 2 contained mosquito larvæ, showing a falling off in their use as food as their numbers diminish.

Similar treatment was given to a shallow bay (fig. 1) at Globe Camp (J 3) on Car Pond. This exceeds 500 feet in length and averages 300 feet wide. At its head and along its eastern side was a heavy growth of emergent vegetation, chiefly grasses, while in the open water just off the shore was a dense barrier of Ceratophyllum and Utricularia. Along this side and about the head a low rocky shore was favorable to the formation of many small pools isolated by rocks and other barriers from the open waters (fig. 4). When first examined on July 7, 1919, an area exceeding an acre was badly choked with driftwood and débris in addition to the vegetation. In this stagnant area Utricularia, Lemna, and filamentous algæ were growing luxuriantly, the water was somewhat contaminated by kitchen drainage from one of the camps, and conditions were ideal for breeding of *Culex pipiens*. Large numbers of the larvæ and egg boats of this species were found not only in the choked part of the bay, but also associated with *Aedes sylvestris*, especially in the isolated pools (40+ per sample). Fishes (mud minnows, common sun-

fishes, and young roach) were abundant on the clear shores and among the more open vegetation.

On the afternoon of July 11 this area was cleared of obstructions, some grass was cut and removed, and some detached pools were opened up. Some of the latter and several small portions of the former were allowed to remain unchanged as checks. On July 12, a. m., a collection of fishes (Table 7, No. 2335, p. 44) was made close to shore in the opened waters. Six of 10 sunfishes examined contained Culex larvæ; 1, a pupa. On July 15 mud minnows and sunfishes in large numbers had penetrated to all parts of the opened area and the breeding rate had fallen to an average of 3.6 per sample, while it averaged 25, including a few Anopheles, in unopened parts.

On July 24 swarms of young sunfishes averaging about three-fourths of an inch long were feeding here close to shore. There were also a few yearling sunfishes, mud minnows, and a few blue-spotted sunfishes. Collections were made at three points—on the originally clean shore where mosquito breeding had not been observed, on the shore at the head of the opened area, and within several of the opened pools. Sample stomach contents of these are shown in Table 7. Of the first lot, five stomachs (No. 2356b) contained no mosquito larvæ; of the second lot (No. 2356d), 6 out of 10 of the stomachs showed a total of at least 13 larvæ and 2 pupæ together with several egg boats; of the third lot, every stomach examined contained larvæ, those (No. 2357b) shown in the table being all that were taken in one pool. The 4 contained at least 14 larvæ and 1 pupa. The remaining stomach contents were a few chironomid larvæ and entomostracans. In spots where two weeks before the breeding rate exceeded an average of 40 the number had fallen to 3.6 where the fishes had entered, whereas in pools and small areas from which they had remained debarred the average now exceeded 50 per sample.

On July 30 the average population of larvæ in opened-up pools from which mud minnows and sunfishes were collected was nearly 4 (mostly newly hatched) per dipper, while exactly similar check pools containing no fishes so far as could be ascertained ran from 45 to 80 or more, of which about 20 per cent were nearly full-grown larvæ, 3 or 4 per cent pupæ, and the rest mostly young stages. Both contained egg boats in about equal numbers. Large numbers of young sunfishes (Table 7, No. 2362b) about an inch long were taken alongshore close to the pools. The stomachs of 3 out of 10 of these contained mosquito larvæ, the bulk of the contents being chironomid larvæ and entomostracans. Five stomachs of fishes taken directly from the opened pools all contained mosquito larvæ, the remaining contents being similar to the last.

Mosquito production in the opened waters continued at a low point throughout August. On August 23 breeding in the opened waters was at the rate of 1½ small larvæ per dipper and in the checks 12½ per dipper, including 8 per cent of last stage larvæ and 2 per cent of pupæ. In the shallow water fishes were much less in evidence on this date, but some small sunfishes, roach, and horned pout were seined close to shore. Of 6 of the former examined (Table 7, No. 2378a and 2378b) one 32 mm. long contained some eggs and larval bristles of *Culex pipiens*, and one yearling 3 full-

grown intact *Culex pipiens* larvæ. In the others no mosquito remains were found among the chironomid larvæ which formed the chief item of food of the larger and Entomostraca of the smaller fishes. On August 27, 1 larva per dipper in the open waters and 20+ in the checks were found.

Both of these areas (D 1 and J 3) as well as others were examined in August, 1920. Mosquito breeding about the lake shore generally at that time was at a low ebb. It was evident, however, that the work of the summer of 1919, supplemented by further clearing up of the shore lines while the water level was lowered, had had a lasting effect. Small sunfishes and other fishes were plentiful, and careful search in the opened areas disclosed absolutely no mosquito larvæ. In sample check pools and other spots that remained closed to the fishes counts averaged for 10 samples each 2, $2\frac{1}{3}$, $3\frac{1}{2}$, $6\frac{1}{2}$, 18, and 20, most of the larvæ being *Culex pipiens* but some *Aedes sylvestris*.

The above recorded data, together with many others of a similar character, should remove any doubt concerning the place occupied by the common sunfish in natural societies in which they are associated with breeding mosquitoes. It is unquestionably an important agent antagonistic to the multiplication of the latter, the aquatic stages of which serve as food. Under the most favorable circumstances this influence may amount to total suppression, in which, however, other fishes usually play a part. It is seldom that such favorable conditions exist throughout the entire extent of a pond or other body of water or continue through the entire season. Usually some mosquitoes will be produced in any body of water offering otherwise favorable conditions, and it is evident that in many cases the density of the immature mosquito population varies positively with the limitations placed upon the activity of sunfishes in feeding upon them.

These limiting conditions are numerous and often delicate and complex. The principal ones disclosed by the data recorded in this paper are (1) the presence of barriers which more or less fully prevent the passage of the fishes and (2) an abundant supply of other easily accessible food. Under the former head the most important are dense growths of plants and a great variety of other mechanical obstructions which cut off areas of water often of very small extent and provide shelter and concealment where the mosquitoes may breed nearly unmolested. But the barriers may be physiological, such as result from changes in acidity,[5] temperature, or contamination of the water. The influence of the food supply is complex and bears a close relation to the density of the fish population. If other food is abundant and the number of mosquito larvæ small, the latter occupy a correspondingly unimportant place in the diet; but if for any reason the total available food supply be reduced or the supply of mosquito larvæ available to the fishes be increased, the percentage of the latter found in the food correspondingly rises. The influence of the fishes on mosquito breeding is therefore one of compensatory regulation which operates most vigorously when mosquitoes are breeding in large numbers and other equally accessible food is scarce and which falls as the supply of mosquitoes is diminished until a point of equilibrium for the existing conditions is reached. How to bring the mosquito element in this balance to the lowest possible

[5] H ion concentration may be an important factor, which of the author's students has agreed to investigate.

numerical point is the practical problem of natural mosquito control, but it is obvious that the sunfishes may be utilized in effecting it.

Little more than this can be said for any species of fish that has been used in mosquito-control work. Both *Fundulus heteroclitus* and *Gambusia affinis*, the value of which is now acknowledged by practical antimosquito workers, are subject to similar limiting conditions, though not in exactly the same combinations or degrees. The recognition of this fact in the case of Fundulus is the fundamental principle underlying the practical method used in controlling the salt-marsh mosquitoes, and Hildebrand (1919) has recently laid great stress upon the importance of plant growths in limiting the effectiveness of Gambusia. The author was much impressed with this fact during a visit of inspection of some of the antimalaria work in the South during the summer of 1918. It was very rarely that some Anopheles larvæ could not be found in bodies of water occupied by Gambusia. It is also probable that the factor of food supply operates with this species much as with the sunfish. The author has in mind particularly a small pond situated near the village of Hamburg, S. C., which swarmed with Gambusia and in which large numbers of Anopheles larvæ of all stages could be seen easily not only sheltered in Confervæ pads and among débris, leaves, etc., but also to some extent floating in open spaces apparently in full view of the Gambusia. In this pond were great numbers of entomostracans, naidiform annelids, and various small insect larvæ. The Gambusia reacted toward the mosquito larvæ exactly as sunfishes do when overfed, and doubtless they were in the same state of satiation.

In addition to the nine species of fishes treated above there is reason to believe that several others may have a supplementary or under special conditions even a primary value in mosquito control. Several of the minnows (Notropis) belong in this category. Like young roach, *Notropis chalybaeus* and *N. bifrenatus* were observed to snap up mosquito larvæ with great eagerness when fed to them in the waters in which they lived under entirely natural conditions. Some experiments with these planned for the summer of 1920 had to be abandoned. A most unexpected observation was the presence of Culex larvæ in the stomachs of several of the swarming young of the yellow catfish (*Ameiurus nebulosus*). The stickleback is another species worthy of investigation. About the shores of Carnegie Lake at Princeton, N. J., there appears to be a close negative correlation between this species and the presence of mosquito larvæ, including Anopheles. The young of the smallmouth black bass were observed on one occasion in Little Long Pond, Palisades Park, to feed eagerly on *Culex pipiens* larva when a boat half filled with water containing large numbers of them was emptied.

SOME GENERAL CONCLUSIONS AND CONSIDERATIONS BEARING UPON THE USE OF FISHES TO COMBAT MOSQUITOES.

In the preceding section there was presented considerable evidence that small fishes exert a powerful repressive influence upon the emergence of mosquitoes from fresh waters. This applies particularly to ponds, lakes, and sluggish streams under natural conditions. The relatively small numbers of mosquitoes produced by such

waters result chiefly from this influence. Indeed, it may safely be said that were these fishes suddenly to be wiped out mosquitoes would immediately and generally become intolerable nuisances. That the latter statement is not fanciful is sufficiently shown by the very numerous cases where precisely this result has followed such local disturbances of the balance. Many instances could be cited (for several see p. 25–26) where through human interference waters have become inaccessible or unsuited to mosquito-eating fishes chiefly through industrial or domestic pollution and thereupon have produced vast numbers of mosquitoes where previously there were few or none. Not a few of the worst mosquito pests from which the more populous regions of the northeastern States suffer are in whole or in part man made.

Nevertheless, vast numbers of mosquitoes are produced under undisturbed natural conditions. Witness the enormous swarms that occur at certain seasons even in many regions nearly or quite uninhabited by man. For the most part these arise from temporary or other fishless waters. But even in waters in which fishes abound mosquito control is seldom or never perfect. Almost always some breeding may be detected, and it is evident that great differences in completeness of control exist in different ponds, in different parts of the same pond, or even in the same parts at different seasons. Frequently from ponds abundantly stocked with mosquito-eating fishes great numbers of mosquitoes will emerge at a certain part or season while otherwise they are effectually checked. To what may this variation be attributed? Evidently the initial rate of mosquito breeding is not the primary factor, for there is abundant evidence to show that with increase in the number of eggs laid and hatched within a given area there is a corresponding increase in the number eaten, so that this relation is largely self-regulating. There are other conditions limiting the degree to which aquatic stages of mosquitoes enter into the diet of fishes.

If fishes are to be employed to the best advantage in mosquito-control work, these limiting conditions must be clearly defined. While in their entirety they are complex and variable with species and conditions, some of them are brought out by the studies described in the section on "Methods and Results of Investigations on Fishes" (p. 7). In the first place, the farther typical pond conditions are departed from and the more closely typical still-water swamp conditions are approached the less effective fish control becomes until a point is reached at which it appears to cease altogether. Both direct observation and experiment show that shallow water in itself does not deter the fishes, for young sunfishes and others will enter and feed in the very shallowest water clear to the actual shore line. If the water be physically fit, nothing but actual mechanical barriers will prevent the entrance of the more aggressive species, as was shown experimentally. It is the broken and obstructive character of the waters and perhaps in addition the absence of deep-water retreats that debars them.

By far the most generally prevalent and effective of such barriers is the vegetation growing in the shallows and at the shore. If these growths be dense, they will almost always afford shelters in which

mosquitoes and especially the anophelines breed freely. This fact is so well known that such areas are generally recognized by antimosquito workers as potential mosquito producers. Students of mosquito-eating fishes also have pointed to the vegetation as enabling large numbers of larvæ to escape the fishes and to mature. As dealing with these waters, Seal, Smith, and Hildebrand may be cited. In most mosquito-control work in fresh waters much money is spent in removing vegetation, chiefly to facilitate spraying with larvicides, but partly to give access to fishes. Numerous observations agree that the latter respond promptly and effectively to such treatment. There is little doubt that in most uncontaminated ponds the problem of fuller mosquito control resolves itself mainly into a problem of plant control. If the plant barrier can be kept within bounds, the fishes will usually find and destroy most of the mosquitoes. To keep the vegetation under subjection it is customary to cut it with scythes or submarine saws or to uproot with suitable tools and rake it out on the banks. This is effective while it lasts, but because of the repetition required becomes expensive.

A number of observations made or collected by the writer indicate that a simple, effective, and economical method of accomplishing adequate control without actual destruction of the marginal and submarginal pond flora may be found in bodies of water in which the level can be regulated. This consists in alternately raising and lowering the water level so that periods in which the emergent and marginal vegetation is completely submerged and denied access to the air and full light are followed by periods when it is left high and dry above the water, exposed to the desiccating action of sun and wind.

It is not intended to present here the full data upon which this suggestion is based. Such material is being gathered for later publication, which also awaits the results of some experiments being carried out in Palisades Interstate Park under the direction of the chief engineer, Maj. W. A. Welch. Every observant person must have seen cases illustrating the repressive action on plant life of change of water level, and the striking effects of permanent drying of a swamp or pond or of the flooding of a new area previously dry are familiar to everyone. In the first instance aquatic plants disappear and the area is occupied by land plants; in the second, the reverse takes place.

Where changes in level are restricted similar but less extensive readjustments take place. When they are temporary, the changes are initiated but checked and by reestablishment of the former levels reversed. Not infrequently it is noticeable that ponds serving as sources of industrial or domestic water supply in which the water level fluctuates markedly because of unequal seasonal consumption or of unequal supply have a sparse flora. The same is often true of rivers which become low during the dry period of late summer and autumn and full in the spring and early summer, as compared with rivers of steady volume of flow. It is also true of canal locks as compared with the uniformly filled body of the canal. It is sometimes the practice in pleasure parks open in the summer only to empty boating ponds during the winter. Such ponds are usually, if not always, barren of true aquatic and emergent plants. The author has known of a few ponds in which a well-established flora was greatly depleted by this custom. An

oscillation of only 1 foot twice repeated during the summer of 1919 produced an appreciable weakening effect on the vegetation of a pond near Media.[6]

Among information and opinions furnished by others, an excerpt is quoted with permission from a letter from Clyde B. Terrell, who has had much experience in developing aquatic game preserves:

> Where it is possible to periodically lower and raise the water level, as you mentioned in your letter, this is possibly as good a method of destroying the vegetation as any. In our work of planting feeding grounds for ducks, fish, and game we have often had to remove undesirable growths to make room for the more desirable plants to provide food. * * * I know from personal experience that it is difficult to make any kind of vegetation grow where the water is constantly raised and lowered, especially if one can effect the change of depth of water of 8 or 10 feet. * * * I have noticed that the establishment of aquatic growth was difficult where the water was raised and lowered by dams. I have two places in mind, one on the Coosa River, near Talladega Springs, Ala., and the other at Lake Delta, near Rome, N. Y.

The ecological principles involved are manifest. The fixed pond margin flora is a complex made up of three principal associations, the submerged aquatic, the aquatic emergent, and the landward marsh plants. These are in constant and severe competition, but as each species grows best under certain optimum conditions of depth, bottom, soil, etc., the zones which they occupy remain clearly defined so long as the level remains constant, but when the water level fluctuates these optimum conditions shift and the zones become ill defined and overlapping. If the level be varied at such periods that optimum conditions for few or none of the plants are maintained for a time sufficiently long to enable them to become well established at the new levels, not only is competition increased, but nearly every component of the flora is weakened by unfavorable conditions of changing severity. It is to be expected, therefore, that the flora as an aggregate will deteriorate. The details of the process are familiar to every field biologist and need not be dwelt upon here.

Inasmuch as different species of plants differ greatly in their adaptability and powers of resistance to this treatment, what is most needed is that the frequency, length, and season of the periods necessary to effective control of particular associations and species should be worked out experimentally. A few long periods of considerable amplitude of change will prove more effective than many short ones of little change as the adaptive factor of safety of most plants will carry them through the latter. A whole association of plants has become adapted to and thrives under diurnal tidal fluctuations. But there is an experimentally determinable limit of endurance. The more the physiological factor of safety is strained the more the plant will suffer. What is harmful to one type of plant will prove beneficial to another, and reversal of conditions should take place before the replacing types have become well established. These compensating effects will prove the best index for determining the number and length of periods and the range of oscillation necessary to secure the most complete control. Probably some plants, especially perennials, will require supplementary measures.

If persons desirous of effecting mosquito control in ponds by means of fishes would employ this method wherever possible, a suitable

[6] In a paper published while this report was in press Headlee (1921, p. 172) recommends dropping the level of water about 12 inches in June and returning it to the former level at the close of the season as a means of opening the plant barrier to fishes.

technique could be quickly worked out and the practicability and limitations of the method determined. By what means and under what conditions it can be economically applied, and how it may be adjusted to the uses to which the ponds are put are questions for the engineers to determine. In the lakes of Palisades Park these have been solved, at least tentatively. In glacial and other lakes of fixed level mechanical means must continue to be employed.

A second limitation depends upon the available food supply. The experiments with the common sunfish show that during periods of great abundance of other food the number of mosquito larvæ destroyed decreases and the rate of residual breeding and number of winged mosquitoes produced increases. There is also some evidence that the same holds true of other species of fishes. To maintain a maximum antimosquito efficiency of the fishes the general food supply should be kept at a minimum. When the fishes are hungry they are more alert and active foragers and will seek out and eat more mosquitoes than when overfed. As food supply relative to the consuming population and not the absolute food supply is the factor with which we are concerned, it is clear that a pond containing a superabundance of fish food is generally one insufficiently stocked with fishes. This condition is therefore best remedied not directly but indirectly by increasing the fish population. This reaches a higher maximum when a variety of fishes rather than only one or two species are introduced. Doubtless the most satisfactory conditions will result in ponds stocked not only with a variety of small mosquito-eating fishes but with suitable food and game fishes as well. The fry of black bass, calico bass, and doubtless of other similar species will eat mosquitoes and compete for the other food of the small fishes. The reduction of the flora will assist by its direct influence upon the insects and other animal fish food dependent upon it.

As a third important condition for permanent stocking, care must be taken to provide suitable conditions for propagation. This includes not only suitable places for oviposition or nesting sites but means for insuring the safety and food supply of the young. Exactly what will be required depends upon the species involved and the characteristics of the body of water. In general, the welfare of the fry is best secured by providing shallow refuges and shelters to which they can escape and where they can find suitable food. This desideratum comes somewhat into conflict with that of reduction of plant barriers, for conditions affording shelter to fish fry may also afford shelter to mosquito larvæ. This is an additional reason for not completely destroying the shallow-water vegetation. Most of the larger fishes are deterred by a plant screen of a density that the smaller ones and fry will pass, and the presence of predacious fishes in the deeper water outside of the screen may be expected to concentrate the mosquito-eating fishes in the very areas where they will meet with the mosquito larvæ. The ideal should be to provide conditions that will afford the maximum concentration of mosquito-eating fishes with the minimum of shelter and protection to breeding mosquitoes. There is little doubt that this can be attained through intelligent experimentation. If a thoroughly rational system of balanced aquiculture is once worked out, it is probable that many ponds will produce fish food for human consumption having a value exceeding the cost of establishing and main-

taining an efficient and almost self-operating natural mosquito control.

These studies also illustrate the general attributes that a species of fish should possess in order to be of value in mosquito control. They are: First, that it will eat mosquito eggs, larvæ, and pupæ, when accessible, at least as readily as other food; second, that it can maintain itself in the habitat and biota to which the mosquito belongs; third, that it can propagate rapidly under the conditions afforded by the bodies of water concerned; fourth, that it is abundant, widely distributed, and adaptable; and, fifth, that it is active and of aggressive habit. There are other qualities requisite for particular conditions, but the usefulness of any species is limited by the degree to which it departs from the maximum of the five characteristics named.

SUMMARY.

1. No fish to which mosquitoes are more than an incidental item of the diet has been found in the fresh waters of the northeastern States.

2. Several species of small fishes and the young of some larger ones native to these waters eat mosquito larvæ, pupæ, and eggs more or less habitually.

3. The most important of these mosquito repressors are the common sunfish, the mud minnow, and the common killifish.

4. Fishes are far more detrimental to culicine than to anopheline mosquitoes. While in the aggregate fishes destroy vast numbers of eggs, larvæ, and pupæ and (along with other enemies) probably prevent mosquitoes from becoming everywhere an intolerable nuisance, the destruction is never complete. Some breeding of mosquitoes continues in nearly all bodies of fresh water even when well stocked with mosquito-eating fishes.

5. This imperfect suppression arises through conditions limiting the efficacy of the fishes, most important of which are (*a*) the barriers that almost all natural bodies of water afford and which prevent the fishes from finding the young mosquitoes, and (*b*) abundance of other food for the fishes. Water contaminated by an excess of decaying vegetation, or otherwise, favors mosquito production, inasmuch as most native mosquito-eating fishes do not thrive in such water.

6. The most prevalent barriers are the shallow water and marginal vegetation.

7. In ponds formed by dams provided with head gates a simple, effective, and economical method of controlling and reducing the marginal vegetation is by lowering and raising the water level periodically, thus alternately drying and drowning the plants. In ponds and lakes of fixed level mechanical means of clearing the margins must be employed.

8. The most practical method of keeping the per capita food supply low is by overstocking with a variety of small fishes. Reduction of the vegetation also diminishes the supply of fish food.

9. Rapid multiplication of small fishes should be encouraged by providing suitable nesting sites and protection for the fry.

10. The common sunfish is the most useful species for ponds and lakes generally. With it may be associated the long-eared sunfish, roach, some of the smaller minnows, black bass, etc. If there is much aquatic vegetation, the blue-spotted sunfish will prove a valuable

addition; if very shallow or swampy areas occur, the mud minnow. The common killifish is very effective in fresh and brackish tidal marshes, and the translucent killifish is useful in upland creeks and dams.

11. Gambusia has not survived the northern winters but multiplies so rapidly that it may be used effectively against both Culex and Anopheles in small ponds and water gardens by planting a small number each spring. Small goldfishes are useful in fountain basins and small ponds with clean sides and are preferable to Gambusia for use in rain barrels and tanks.

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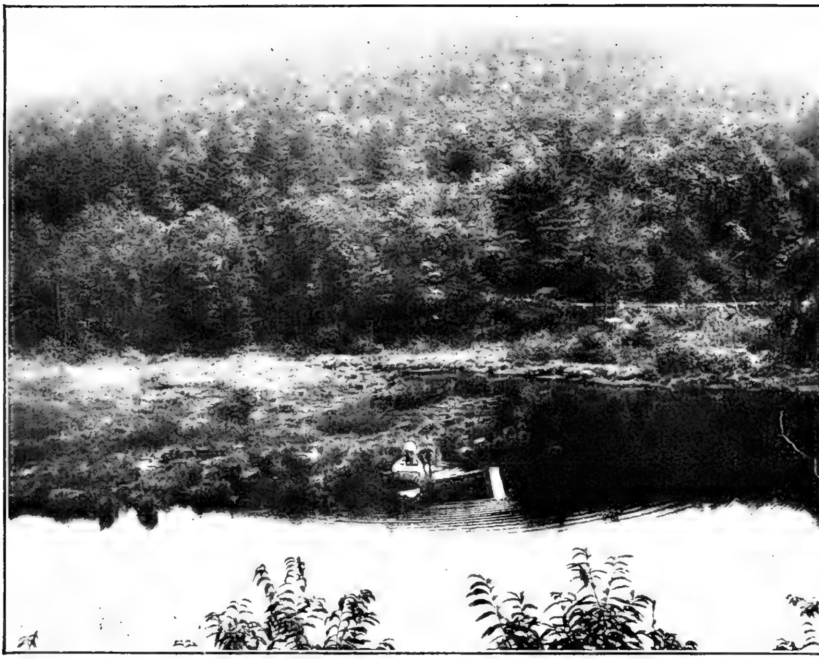


FIG. 1.—Globe Camp bay, Palisades Interstate Park, showing the plant-grown area (Sta. J) at its head.

FIG. 2.—Globe Camp bay showing details of vegetation and shore conditions at mouth of Stahahe Brook near pool J 6.

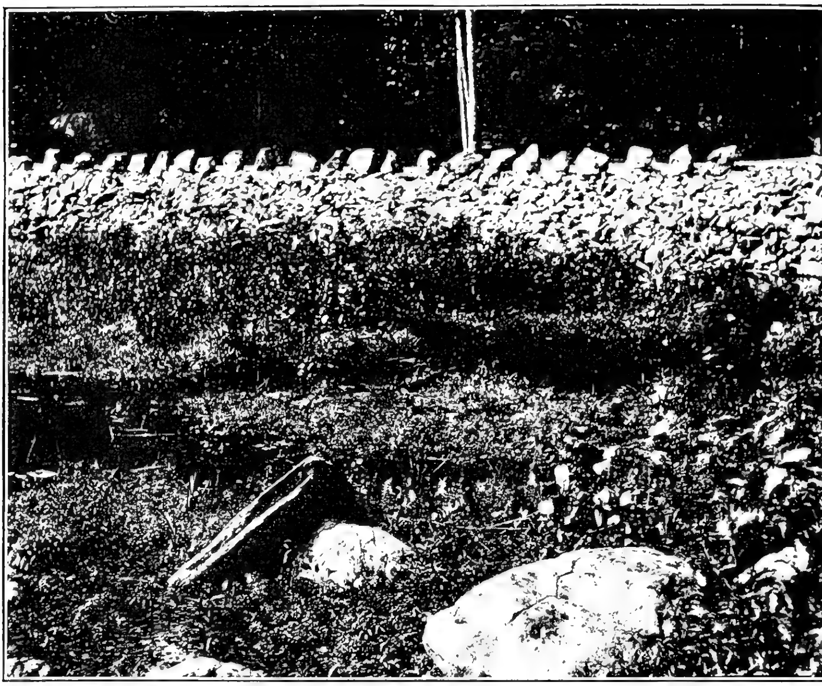


FIG. 3.—Pool J 6 after opening the passage into the bay toward the left.

FIG. 4.—Head of Globe Camp bay showing shore conditions with mosquito-breeding pools and obstructions on July 9. The upright stake marks pool J 4 which was opened by removing the stone and logs on the opposite side. Compare figure 5.

FIG. 5.—Head of Globe Camp bay after removal of obstructions, showing the pool J 4 opened into the lake. The stake marking it is inclined. Compare with figure 4.

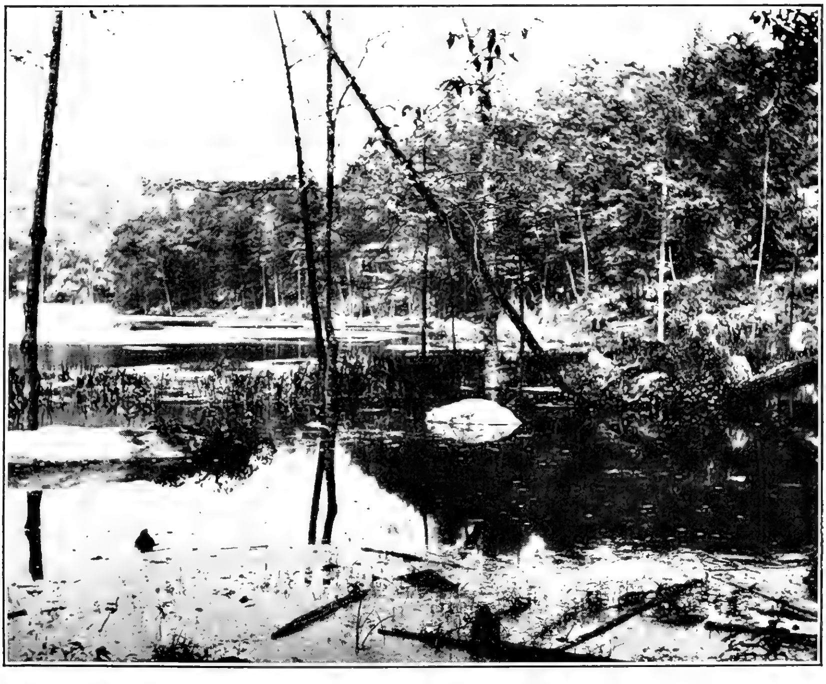


FIG. 6.—Head of Brooklyn Industrial cove, Palisades Interstate Park, showing obstructions in the mosquito-breeding area in the foreground (D 1), July 9.

FIG. 7.—The same cove as in figure 6 showing emergent vegetation, etc., at mouth of a rivulet (D 4), July 9.

FIG. 8.—The head of Brooklyn Industrial cove after clearing out driftwood and brush and opening of passages through the vegetation. Taken a little to the left of figure 7 with the camera farther from the water.

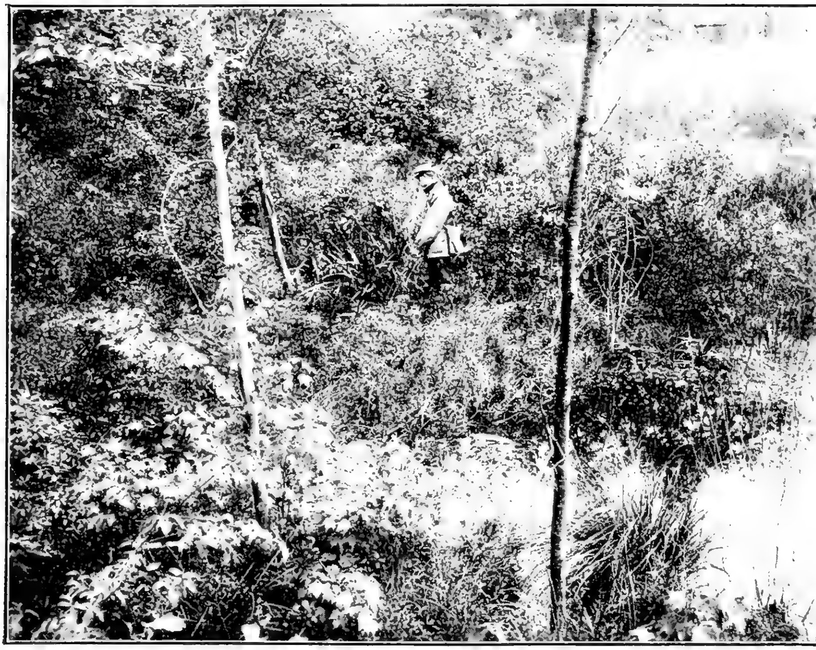


FIG. 9.—Shore conditions on west side of Cedar Lake, Palisades Interstate Park, showing character of the vegetation at shallow bay where blue-spotted sunfish abound. At the right are the lake waters. At the foot of the man is a cut-off mosquito-breeding pool (M).

FIG. 10.—Details of the pool (M 1) showing the broken Lemna mat and clear patches of water on one of which a library card is floating. No fishes were found here.

FIG. 11.—Rock pool (M 2) on shore of Cedar Lake, the lake waters to the left foreground, a library card floating on the surface of the pool and a tree root and rock separating the two.

FIG. 12.—The inlet of the larger pond in the University of Pennsylvania botanical garden showing one of the screen check pens (A 6).

FIG. 13.—Another portion of the same pond (A 3) shown in figure 12, illustrating the character of the shore and emergent vegetation.

FIG. 14.—Portion of smaller pond (B), University of Pennsylvania, showing character of marginal vegetation. The Lemna mat which later in the season completely covers this pond has not yet appeared. This pond was used for Gambusia experiments.

MORTALITY IN PIKE-PERCH EGGS IN HATCHERIES.[1]

By Franz Schrader, *formerly Fish Pathologist, U. S. Bureau of Fisheries,*
and
Sally Hughes Schrader, *Temporary Assistant, U. S. Bureau of Fisheries.*

The remarkable losses in the hatching of pike-perch (*Stizostedion vitreum*) eggs have frequently made this phase of fish culture a ground for investigation. It is, however, not unjust to say that very little detailed study has been made and that no definite conclusion as to the causes of the high death rate has ever been reached.

The methods used in the handling of parent fish and eggs are, in the main, very much alike at the various stations that hatch pike perch. The fishes are caught in nets that are usually pulled once a day, weather permitting. Those that are ripe are stripped immediately, either in the field or at the hatchery, while the rest are retained in pens or live boxes. They are examined in turn daily until found to be ripe. In some years the sexes are found to be disproportionate in number. If males are scarce, the same individual may be used to obtain milt on several successive days. Fertilization is by the dry method, no water, or very little water, being used in the process. Milt and eggs are stripped into a bowl in more or less regular alternation, and the whole is gently stirred at frequent intervals to insure the contact of the eggs with the sperm. When the bowl is sufficiently full—generally after 10 to 15 minutes—the contents are diluted with water which after a varying period is poured off and renewed until the eggs are contained in clear water. Cohesion of the eggs, which at this time are extremely sticky, is prevented by active stirring or by adding silt or starch to the water in addition to such mechanical agitation. Finally, after several hours, the eggs are put into the hatching jars through which a gentle current of water is kept flowing.

As already indicated, the losses are very great. Nevin (1887) considers a hatch of 50 per cent a very fair success, and this would be agreed to by most fish-culturists. The cause of this great mortality is, in general, ascribed to failure of the eggs to be fertilized or else to injuries incurred while the eggs are being handled, especially the active stirring and the addition of foreign materials to prevent cohesion. It seems almost certain that these last-named crude procedures—which so far are unavoidable—are very apt to be

[1] Appendix V to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 926.

harmful, and a certain amount of loss is probably due to them. Reighard (1890) found that by very careful handling of the eggs at and immediately after fertilization the percentage of eggs that started segmentation soon after fertilization could be considerably increased. Describing the loss met with in the ordinary course of the routine methods, he states that in 252 samples examined 11 per cent had died due to lack of impregnation and 33 per cent due to injury. Unfortunately, although he designates the day and hour at which these observations were made, the age of the eggs is not specifically given. From the context it would appear as 29 hours. It seems that an egg was designated as dead when it showed an opaque white color, a criterion which was adopted also in the present investigation.

The figures of the losses in ordinary handling of pike-perch eggs given by Reighard are somewhat at variance with those given by L. H. Almy in some unpublished notes on the pike perch. His findings and those of the authors follow:

Almy.		Schrader and Schrader	
Age of eggs.	Per cent loss.	Age of eggs.	Per cent loss.
3 hours	2.5	1 hour	0.5
27 to 29 hours	5.4	1 hours 30 minutes	1.0
2 days	8.1	8 hours 15 minutes	2.4
3 days	12.6	19 hours	4.3
4 days	31.7	29 hours	5.0
5 days	35.5	2 days	8.3
7 days	39.0	3 days	13.3
9 days	33.4	4 days	33.2
		5 days	37.1

It will be seen that in contrast to the 33 per cent of white eggs given by Reighard, Almy observed only 5.4 per cent at 27 hours, while our own observations are lower still. Almy's and our figures agree fairly well, the latter being lower up to two days and a trifle higher at four days. It is not quite clear to what such a discrepancy could be due, although Reighard's hypothesis of injury as a cause of mortality would, of course, itself allow for large differences on account of the varying skill and care bestowed on the eggs. (Temperature conditions were in all cases apparently the same, the water being in the neighborhood of 45° F.) Reighard describes the injury as taking place most easily over the oil globule, and there is no reason to dispute the observation. However, the following explanation which he advances to account for this phenomenon does not seem to rest on a very firm physical basis (Reighard, 1890, pp. 33, 34):

In the natural position the yolk sphere lies with its lower half against the egg membranes. These membranes, therefore, support this half of the yolk, surrounding it as if it were resting at the bottom of a cup. The upper half of the yolk is, on the contrary, not of the same form as the investing membrane; its spherical surface is interrupted by the protruding oil globule.

The result of this arrangement is that when any pressure is brought to bear on the egg membranes, so that the space within which the yolk lies is reduced, the yolk is able to resist this pressure by fitting itself against the egg membrane at every part of its surface except over the oil globule. The strain,

therefore, comes on that part of the protoplasmic investment of the yoke which covers the oil globule and here it bursts. In almost every case the white spot which indicates the rupture of the yoke investment makes its appearance at the oil globule, usually at the equator.

Almy's as well as our own observations show that the death rate increases rapidly and steadily to the fourth day and then advances more slowly. To begin with, it must be noticed that a small percentage of dead eggs is found practically as soon as the fishes are

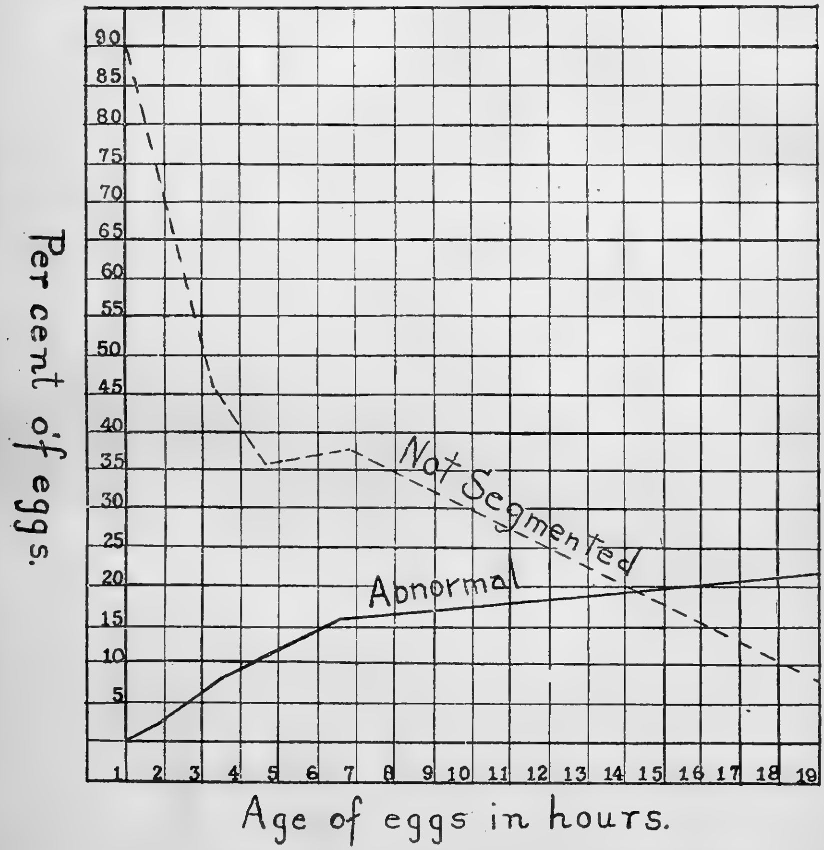
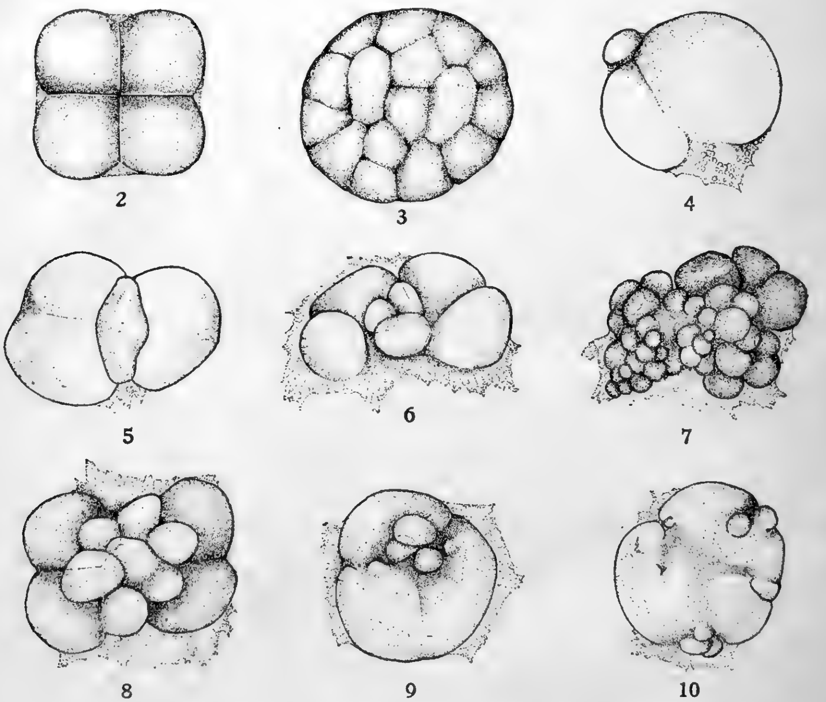


FIG. 1.—Graph showing the variation in numbers of abnormal and unsegmented pike-perch eggs during development.

stripped. It is surmised that these may have been injured in the process of stripping, or that they may have died through some developmental irregularity while still in the fish.

Coming now to the hypothesis that failure of fertilization is responsible for a greater part of the mortality of hatching eggs, it is generally assumed that lack of impregnation and failure to segment are closely correlated. A detailed examination of the material does not bear this out. We found that in eggs 4 hours 30 minutes old there was a considerable percentage which showed no trace of cleavage. This was true also at 5 hours 30 minutes, 6 hours 45 minutes, and

even 8 hours 15 minutes. Most of the unsegmented eggs at the latter stages on being examined cytologically appeared to be normal. They were therefore merely lagging behind. The proportion of eggs which has failed to cleave becomes progressively less with age, which in itself supports the idea that we are dealing here rather with a delay in cleavage than with a lack of impregnation. The curve in figure 1 (p. 3) shows graphically the numerical conditions encountered. These data are emphasized here merely to show that it is manifestly impossible even after eight hours to designate eggs as unfertilized when the absence of segmentation is taken as a criterion.



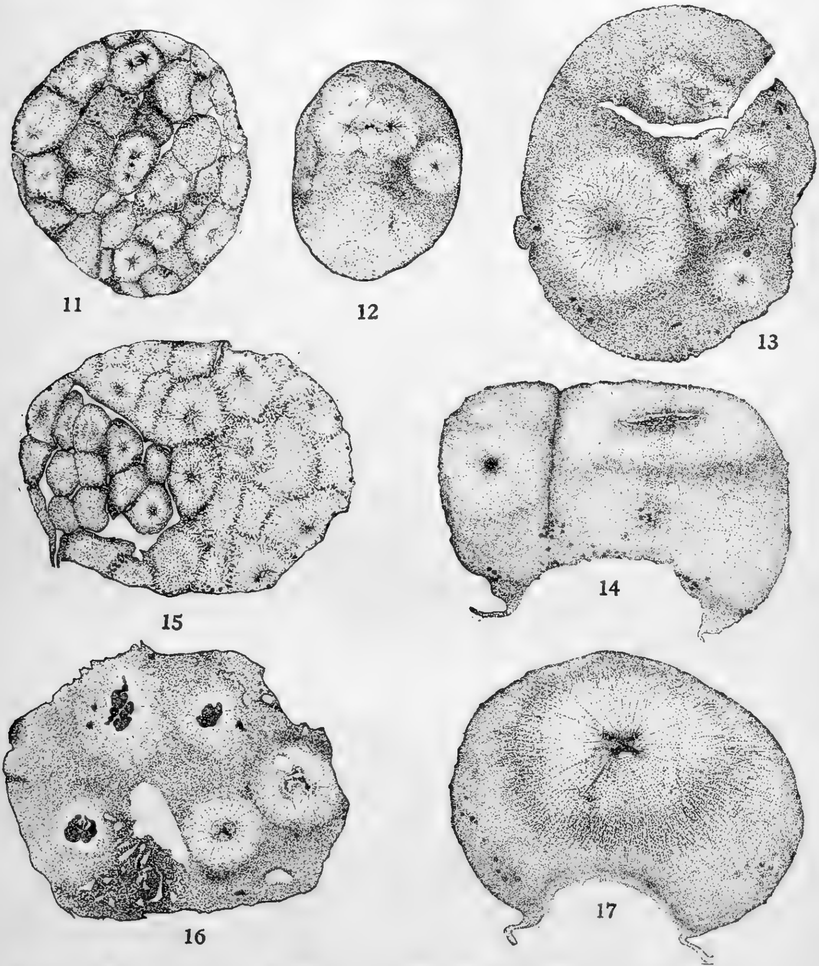
FIGS. 2 to 10.—Surface views of pike-perch eggs. Magnification, approximately × 100.

FIG. 2.—Normal 6-hour 4-celled blastoderm.
FIG. 3.—Normal 19-hour blastoderm.
FIG. 4.—Abnormal 8-hour blastoderm.
FIG. 5.—Abnormal 10-hour blastoderm.
FIG. 6.—Abnormal 10-hour blastoderm.
FIG. 7.—Abnormal 19-hour blastoderm.
FIG. 8.—Abnormal 19-hour blastoderm.
FIG. 9.—Abnormal 29-hour blastoderm.
FIG. 10.—Abnormal 29-hour blastoderm.

In addition to all this it must be considered that in the artificial insemination of the pike perch the eggs are immersed in milt which is diluted very little. The chance of a normal ripe egg remaining unfertilized must therefore be extremely small, and, as a matter of fact, it is surprising that polyspermy is not more often encountered.

In addition to the eggs which are found to be dead almost immediately, and to those which are slow to cleave, there is a third class which has been designated as "abnormal." In explanation it must be stated that minor irregularities in cleavage are not necessarily an indication of pathological conditions (H. V. Wilson, 1891), and only such extreme cases as are shown in figures 4 to 10 were rated as

abnormal. Eggs showing normal cleavage are shown in figures 2 and 3. Extreme variations, such as are shown in figures 4 to 10, in size of cleavage cells were found in nearly all cases to be correlated with internal conditions which presaged embryonic death sooner or

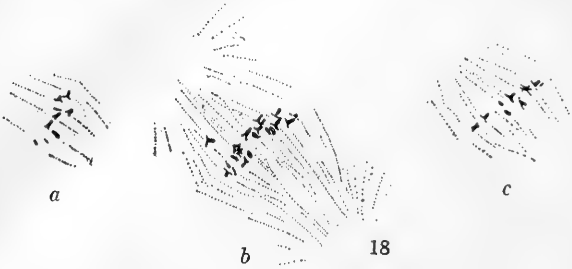


Figs. 11 to 17.—Sections of pike-perch eggs. Magnification, approximately × 200.

Fig. 11.—Horizontal section of a normal egg of 64 or more cells.
Fig. 12.—From a 29-hour egg showing cytasters and abnormal spindles.
Fig. 13.—From a 29-hour egg showing size variation in cytasters.
Fig. 14.—From an 8-hour 15-minute egg, showing elongated nucleus.
Fig. 15.—From a 29-hour 15-minute egg, showing partial segmentation.
Fig. 16—From a 29-hour 15-minute egg showing degeneration in chromatin and multiplication of chromosomes.
Fig. 17.—From an 8-hour 15-minute egg showing monaster.

later. The number of such abnormal eggs increased steadily with age, ranging from 1 per cent at 4 hours 30 minutes to 21 per cent at 19 hours. As the curve in figure 1 shows, this increase runs parallel with a decrease in the number of unsegmented eggs, which suggests the possibility that such abnormal cases are derived chiefly

from eggs which are slow to cleave. It may be remarked that it is difficult to draw a strict line at times between the abnormal and the



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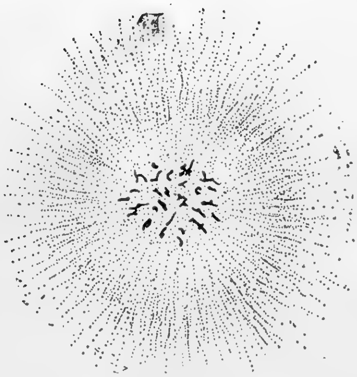

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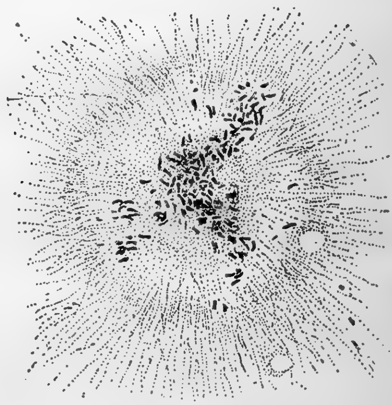

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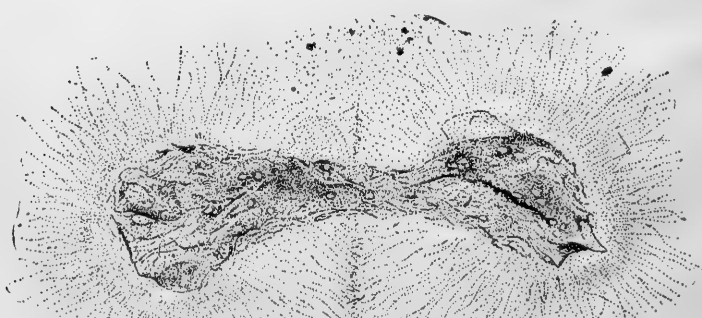

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FIGS. 18 to 22.—Sections of pike-perch eggs. Magnification, approximately × 1620.

FIG. 18*a*, 18*b*, 18*c*.—Side views of three sections of a plate showing 30 chromosomes, the normal number.
FIG. 19.—Side view of a plate in another cell in the same blastoderm as figure 11, showing 15 chromosomes, the haploid number.
FIG. 20.—Polar view of normal plate.
FIG. 21.—Abnormal multiplication of chromosomes.
FIG. 22.—Abnormal elongated nucleus—abortive division.

unsegmented types in the first few hours. At that time one or a few minute excrescences are occasionally budded from the germinal disk,

and it becomes a question whether these should be regarded as cells or not.[2] On the other hand, at the 29-hour stage, abnormal eggs are often segmented into such small cells in such a way that, externally, it is very difficult to tell them from normal eggs, although internally they may be shown to be very irregular in behavior. The intermediate stages are therefore the best material for this phase of the investigation.

Those cytological features in the development of normal eggs which bear on the work in hand are as follows: Up to the 16-cell stage cell walls are sometimes partially or completely absent, but asters and spindles are normal in size and occupy the same position that they would if there were a distinct separation into cells. Following the 16-cell stage, the cleavage, which becomes externally complete at least in the surface layer of cells, gives evidence of this fact internally by the presence of very distinct cell walls. Mitosis is at first synchronous in all the cells, but this regularity is soon lost, so that certain cells of an egg may be in the resting condition while neighboring cells may be undergoing mitotic division.

As already indicated, cytological examination of uncleaved eggs at 4 to 8 hours showed the majority to be normal (fig. 11, p. 5). The few exceptions were found to have anomalous mitotic figures, and their number was increased in the 8-hour stage. At 29 hours every uncleaved egg showed anomalous internal features. The exceptional 8-hour eggs often show a very large monaster (fig. 17, p. 5). Other eggs may show several cytasters and an occasional spindle (figs. 12 to 16, p. 5). At 29 hours no such large monasters are found in eggs of this type or in those called abnormal and generally there is only an increase of cytasters in the former.

The abnormal eggs often present a curious mixture of spindles and asters of varying sizes, drawn-out nuclei, chromosomal irregularities, and partially formed cell walls (figs. 12 to 17, 21, and 22). Frequently an egg is found in which a part has undergone regular cleavage while the rest is filled with cytasters and shows no indication of cell walls (fig. 15). As it was expected that such irregularities would be reflected in the distribution of the chromosomes in division, evidence of such chromosomal abnormalities was sought. But, as in other teleosts, the chromosomes are usually so clumped that an exact analysis of them is very difficult. In at least one case, however, the metaphase plate in one cell showed close to 30 chromosomes (which seems to be the diploid number as obtained from counts in normal eggs, fig. 20), while the adjoining cell contained only about 15 (figs. 18 and 19). This might be explained as a case of partial fertilization, in which the sperm has instigated a division of the egg nucleus and later has fused with one of the nuclei resulting from this first division of the egg nucleus. The fusion nucleus would then be diploid and the purely maternal nucleus haploid.

Irregularities in cleavage and mitotic figures practically identical with those here described have been obtained experimentally by a number of investigators. It will be noted that in every experiment of this nature the effect is to induce development with one of the

[2] Reighard (1890a) mentions excrescences as occurring in correlation with the flow of protoplasm in the formation of the protoplasmic cap. Since the number of eggs showing the excrescences mentioned above increases long after the formation of the cap, in our case, the phenomenon described by Reighard is probably not related to it.

parent nuclei absent or in a weakened condition, with both in a weakened condition, or with the pronuclei incompatible through hybridization. A limited survey of the extensive literature on this subject will suffice to show the trend of the work.

E. B. Wilson (1901) found that in artificial parthenogenesis, where, of course, only one of the parent nuclei is present, there occur such abnormalities as the formation of cytasters, the multiplication of chromosomes without accompanying cell division, multipolar mitoses, and delay in cleavage. The chromosome number in the eggs which seem to show normal development is haploid.

Dungay (1913) weakened or injured sperms of several species of invertebrates by means of chemical treatment, heat, or staling, and development in eggs fertilized by such sperms resulted in delayed cleavage, abnormally sized cells, multipolar figures, and similar defects.

O. Hertwig (1911) and G. Hertwig (1912), among others, have described the effect of fertilizing eggs with sperms treated with radium. Both authors remarked especially a budding phenomenon correlated with delayed development. They also describe drawn-out nuclei, multiplication of chromosomes in a nucleus, giant nuclei, and cytasters, all almost identical with phenomena which we have described in the abnormal pike-perch eggs.

C. Packard (1914) found that sperms which had been treated with radium may stimulate the eggs to cleave but fail to take part themselves in the subsequent development. When the eggs are "radiated," they show various irregularities, such as abnormal divisions or the failure of pronuclei to unite.

G. and P. Hertwig (1914) produced similar effects to those already mentioned by weakening sperms with methlyn blue among other reagents. Still more striking are the phenomena produced by fertilizing the eggs of teleosts with sperms of another species of teleost. The whole list of abnormalities given above was reproduced in such development.

It is not within the province of applied biology to go into a theoretical consideration of these phenomena. Suffice it to say that the weakening or injury of either sperms or unfertilized eggs will produce the same defects in the development of all animals so far investigated. Physiological and cytological phenomena identical in appearance with those produced experimentally in this way have been observed also in abnormally developing pike-perch eggs, and it suggests itself that the cause of such irregularities is of similar nature. In other words, there is a weakening of either sperms or eggs before fertilization.

It is highly improbable that natural conditions should induce a state that would cause such a large mortality in the embryos, and it becomes almost certain that the injury is incurred during the period of the captivity of the fishes.

As has been said in the introduction, most of the fishes are found not to be ready for stripping when first caught. They are therefore retained in pens or crates until the reproductive products can be obtained from them by stripping; in other words, until they are "ripe." The penning of fishes prior to spawning is a practice of

long standing in the handling of pike perch as well as many other species. Some of these species are known to stand such confinement fairly well, but many show various ill effects, such as hardening of the ovaries, wateriness of milt, and low percentage of hatched fry. Whatever the cause and physiological process involved, be it abnormal hydrogen ion concentration due to the crowding of the parent fishes, or more directly circulatory and nervous relations, the result is a degeneration of eggs and sperms. In the case of the pike perch especially the consequent mortality may, of course, fluctuate from year to year due to such causes as sudden changes of temperature (a sudden change of temperature is known to materially retard the ripening of the fishes in the pens) and weather conditions which may prevent pulling the nets and therefore postpone examination of the caught fishes. Some specimens do not lay eggs even when ripe under such conditions.

It may be of interest in this connection to give the opinions of men who have the supervision of pike-perch hatcheries which are located at Constantia, N. Y., Swanton, Vt., Put in Bay, Ohio, and Duluth, Minn. Their opinions, given in response to a letter of inquiry, are

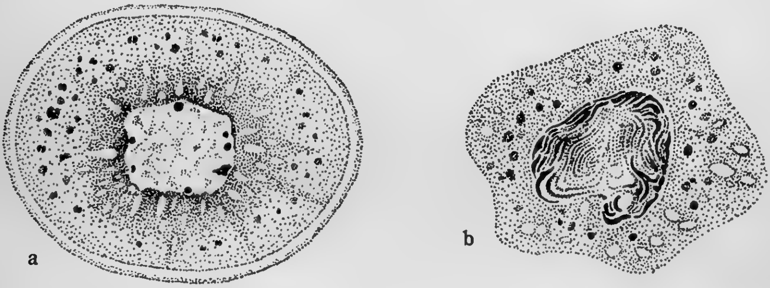

FIG. 23.—Eggs of Stenotomus prior to maturity. *a*, Normal egg; *b*, egg from a parent kept in a tank for two weeks.

not based on numerical data but are the results of practical observation. All of these four superintendents and a fifth, who was formerly connected with pike-perch work, agree that the mortality of eggs is proportional to the time that the adult pike perch are retained in pens and, conversely, that the percentage of hatched eggs from fish stripped when taken from the net is much greater than that of eggs from penned fish. Four of the men believe that both male and female are affected by penning, but that the female is more susceptible, while the fifth does not commit himself on this point but cautions against using the males more than once, i. e., on several days.

Bearing more directly on the problem are some experiments made by the senior author in connection with some other work. Females of the common scuppaug (*Stenotomus chrysops*) were netted shortly before the spawning period and retained in a tank supplied with a continual flow of fresh sea water. Specimen of these impenned fishes were dissected at intervals of a few days and the ovaries examined histologically. A progressive deterioration of the nearly ripe ova was observed, which at the end of two weeks had reached such a stage as shown in figure 23.

The generalization that the high death rate in pike-perch eggs is due to lack of impregnation thus seems to be unwarranted. That the present methods of preventing cohesion of the eggs are responsible for a certain percentage of the mortality is probable, but they do not account for all the loss. On the other hand, it has been shown that about 25 to 30 per cent of representative samples of 29-hour eggs show abnormalities that must lead to either malformation or death. If an average loss is then considered as 50 to 60 per cent (and that is a fair estimate), about half of this is due to the agency which manifests itself in abnormal development. This cause is in all probability to be found in the practice of retaining captured fishes in pens for the purpose of permitting eggs and sperms to mature.

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[3] "Presented at the meeting by Herschel Whitaker and erroneously attributed to him by the editor of the Transactions." (Quotation from Dean's Bibliography of Fishes, Vol. II, p. 329, published by the American Museum of Natural History, New York, 1917.)

SOURCES, PREPARATION, AND PROPERTIES OF SOME ALGAL GELATINES.[1]

By Irving A. Field,

Late Professor of Biology, Clark College, and Special Investigator, U. S. Bureau of Fisheries.

INTRODUCTION.

Many seaweeds when boiled in water yield a highly gelatinous product called gelose, which is employed in various ways in science, medicine, and commerce. The jellies of the different species of algæ vary somewhat in chemical composition and have quite different physical properties. In general, however, gelose will absorb water and swell up but not dissolve unless heated almost to boiling. The solution coagulates on cooling to a more or less colorless translucent jelly. The gelatinizing power in some cases is more than 10 times that of ordinary animal gelatin. Algal gelatines lose their property of gelatinizing when heated with water under a pressure of six atmospheres or when boiled with dilute acids or alkalis. In a hot solution of dilute hydrochloric acid they yield galactose. Treated with nitric acid they yield mucic and oxalic acids. Some of the American seaweeds that yield gelose are discussed below.

IRISH MOSS, CHONDRUS CRISPUS.

Carrageenin is the name given to the gelatinous extract of Irish moss which grows in abundance on the rocky portions of the North Atlantic coast just below low-tide mark. The chief source of supply is centered around Scituate, Mass., where about 30 or more men are engaged in moss collecting. Other localities where the moss is harvested are Cape Porpoise, Portsmouth, York, and Rye, N. H.; Cape Sable, Rockport, Gloucester, Marblehead, Nahant, Cohasset, Plymouth, White Horse Beach, and Cuttyhunk Island, Mass.; Block Island and Montauk, N. Y.

The moss is scraped from the rocks by means of a special rake and spread on a clean sandy beach where it is washed in sea water and sundried alternately several times until bleached white. Dew or light rain assists in the bleaching process, but a heavy rain will ruin the product by extracting the jelly and giving the moss a yellowish discoloration. When ready for market it is packed in barrels or bales weighing about 100 pounds each. In this condition it sold for about 10 cents a pound in 1920.

Chemical analyses show that fresh Irish moss contains 79 to 80 per cent water. The water-free substance is composed of:

	Per cent.
Gelatinous matter	65
Nitrogen	2–3
Lipoids	0.7–1
Ash	10–15

[1] Appendix VI to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 929. First issued as an Economic Circular (No. 51, supply exhausted).

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The ash contains calcium oxalate, sodium, potassium, and magnesium with chlorine, bromine, iodine, and sulphur.

These salts apparently bear an important relation to the properties of the gelatinous matter; for if this matter is extracted after the moss has been washed in fresh water, dilute acid, or alkaline solutions, which would remove the salts, it comes out as a thick mucilaginous mass which fails to jellify on cooling. On the other hand, from quickly dried unbleached moss which has been rinsed for a short time only in sea water and boiled for three to five hours in fresh water in the proportion of 1 part by weight of the dry moss to 50 of water, a stiff gel may be extracted.

Separation of the solution from the insoluble matter is accomplished by filtering the mass roughly through a ¼-inch mesh galvanized screen and then through one or more layers of cotton flannel. The clear filtrate may be evaporated to dryness on a water bath or in a vacuum chamber, ground into fine flakes, and preserved in airtight receptacles for future use. This method of preparation does not seem to be employed commercially, although it puts the carrageenin in a clean and most convenient form for quick and ready use.

The gelatinizing properties of Irish moss are easily destroyed by the addition of small quantities of acid salts and alkalis. Acids in stronger concentrations than 1 per cent N/8 will liquefy the jelly; neutral salts, and especially calcium salts, increase the firmness of the gel. Perhaps this is why such small quantities of carrageenin are capable of coagulating milk.

Irish moss is used in a variety of ways. It is employed as one of the ingredients of so-called water paints. Certain shoe stains contain a solution of carrageenin for the gloss it imparts when dry. As a sizing for paper, cloth, and thread it is considered excellent. Recently a British patent was taken out for Irish moss extract treated with formaldehyde, which makes a size that becomes insoluble after drying. To a limited extent it is used as a thickening for colors in calico printing and for stiffening silk. Soap manufacturers and barbers use it because of the velvety lather it makes with soap. As a clarifying agent, it has been used extensively in the manufacture of oil and beer. Bandoline is a perfumed mucilage of Irish moss that is employed as an ointment for the hair or fixature for the mustache. As a therapeutic, a decoction of Irish moss with lemon juice serves as a demulcent and emollient in pulmonary affections. It is also recommended for scrofulous complaints, dysentery, diarrhea, and disorders of the kidney and bladder. According to the United States Dispensatory:

> Carrageenin is said to have been used as a substitute for acacia under the name of imitation gum arabic; the latter occurs in three forms—white, light yellow, and yellow. They all have similar properties, swelling up like tragacanth when mixed with cold water but not forming a clear solution unless the mixture be boiled, in this latter respect differing from tragacanth or albumen.

Carrageenin extracted from unbleached Irish moss has proved suitable for use as a medium in packing fish that otherwise are too soft to stand up in cans. Experiments show that 1¼ to 1½ grams of the dried extract added to a 14-ounce can of fish are sufficient to form a jelly firm enough to prevent such soft fish as whiting and

herring from breaking to pieces when subjected to the ordinary rough treatment of transportation.

For many years Irish moss has been used as a food, although its nutritive value is very slight. Its importance in this respect lies in the fact that it can render certain very nourishing foods, such as milk, more palatable and increase the variety of ways in which they can be served.

BLANC MANGE.

Blanc-mange pudding is probably the most popular dish prepared from Irish moss. It is made according to the Boston Cooking School Cook Book as follows: One-third cup Irish moss, 4 cups milk, ¼ teaspoonful salt, 1½ teaspoonfuls vanilla. Soak moss 15 minutes in cold water to cover, drain, pick over, and add to milk; cook in double boiler 30 minutes; the milk will seem but little thicker than when put on to cook, but if cooked longer, blanc mange will be too stiff. Add salt, strain, flavor, re-strain, and fill individual molds previously dipped in cold water; chill, turn on glass dish, surround with thin slices of banana, and place a slice on each mold. Serve with sugar and cream.

CHOCOLATE BLANC MANGE.

Chocolate blanc-mange pudding is made by adding to the above hot extract a smoothly stirred mixture consisting of 1½ squares of melted Baker's chocolate in ⅓ cup of boiling water and ¼ cup of sugar. Chill and serve with sugar and cream.

This method, which has been in use for many years, can be simplified greatly by using, instead of the ⅓ cup of Irish moss, 2 level teaspoonfuls of the dry ground extract of Irish moss to each quart of milk placed in a double boiler. It dissolves in about 15 minutes and requires no straining. Besides saving time and the trouble of straining and of washing extra utensils, it conserves materials. The saving of carrageenin, resulting from the use of the pure dry extract, would probably pay for the extra expense involved in its preparation.

AGAR-AGAR.

Agar-agar is the commercial name applied to the dried, gelatinous extract of certain species of red algæ. The algæ most commonly used are *Gelidium corneum*, *G. cartilagineum*, *Gracilaria confervoides*, *Eucheuma spinosum*, and some species belonging to the genera Gloiopeltis[1] and Gigartina. Of these, the Gelidium varieties produce the best quality of agar. Most of the agar of commerce is produced at present in Japan, China, Malaysia, and Ceylon, although there seems to be no reason why the United States should not manufacture more than enough for its needs. During the year 1920 this country imported 240 tons, having a value of nearly half a million dollars.

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[1] In the original manuscript of the author this name appeared as Tenax, which was evidently an error of the copyist. Since the death of the author occurred, just after completing the manuscript in longhand, there was no opportunity for correction of the manuscript by him. Dr. Marshall A. Howe, of the New York Botanical Garden, has offered the following suggestion and comment:

"I suspect that what Dr. Field had in mind was *Gloiopeltis tenax*, which, with other species of that genus, is the source of the 'funori' of the Japanese, a sort of glue that is extensively used in the Orient for the sizing of cloth. Japan is said to produce two or three million pounds of it a year. The word 'agar-agar' appears to be of Ceylonese origin, and the 'Ceylon moss' of southern India, from which the agar-agar of commerce is still in part derived, is chiefly *Gracilaria lichenoides*. Species of Gigartina occur in considerable quantity on the California coast and might perhaps be used commercially in this connection. *Eucheuma isiforme*, a species of Bermuda, southern Florida, and the West Indies, rich in gelatin and of large size, could probably be successfully cultivated in protected salt-water lagoons of southern Florida."

The preparation of agar involves quite a number of steps, but on the whole is a simple process: (1) The seaweeds are collected by hand or rakes and spread upon the beach to dry and bleach in the sun. (2) The dry weed is beaten or pounded by hand or passed through a concrete mortar-and-pestle battery to free it from clinging shells, incrusting Bryozoa, sand, and other foreign matter, and is then alternately washed and sundried again until thoroughly bleached and cleaned. This treatment requires from two to several days. Some manufacturers are said to shorten the process by bleaching with chemicals instead of sunlight. (3) The bleached raw material is boiled with about 50 times its weight of water in an iron kettle for three to five hours to extract the gelose in soluble form. The solution is then separated from the insoluble matter by filtering the mass first through coarse cloths and then squeezing it through linen bags in a press. (4) The filtered jelly is next poured into wooden trays about 2 feet long, 1 foot wide, and 3 inches deep to cool. As the filtrate cools it solidifies into a hard jelly which the Japanese call "tokoroten." In this form it is cut by means of sharp knives into blocks 1 foot long and 2 inches square. These blocks are in turn pressed through a coarse wire grating which cuts them into bundles of slender straws. (5) In this condition the "tokoroten" is subjected to a freezing temperature of —5° to 15° C., either out of doors or in an artificial freezer, until the sticks are frozen solid. This causes the water to crystallize out and when it is melted the substances soluble in cold water drain off in solution leaving the gelose in pure condition. By repeating the freezing and thawing process and at the same time drying the material in the sun and open air a pure agar which is insoluble in cold water is prepared. (6) Before the sticks are entirely dry they are sometimes put through a forcing machine which flattens each fine strip into a transparent sheet. They are then dried in the sun and tied in bundles weighing from ½ to 3 pounds each.

Agar-agar is prepared also in the form of sheets 8 to 12 inches long and 1 to 1½ inches wide, and as rectangular blocks about 8 inches long and 1 inch square.

The chemical composition of agar-agar has been most carefully studied by Carl R. Fellers, whose results are published in the Journal of Industrial and Engineering Chemistry, volume 8, No. 12, 1916, pages 1128–1133. Analyses of 15 samples collected from various sources and representing different brands gave the following results:

	Per cent.
Moisture	15.75–17.84
Protein (N x 6.25)	1.63– 2.94
Nitrogen free extract	72.72–78.21
Ether extract	.17– .45
Crude fiber	.39– 1.60
Ash	3.08– 5.68
Silicon dioxide	.31– 1.11

Another series of analyses based on two samples gave the following results:

	Sample No. 1	Sample No. 2		Sample No. 1	Sample No. 2
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
CaO	1.02	0.82	Cl	0.26	0.17
MgO	.595	.540	I	(+)	(+)
Na_2O	.235	.264	Pentosans	2.996	3.236
K_2O	.062	.072	Galactan	24.34	21.40
$Fe_2O_3+Al_2O_3$	.57	.052	Solution in H_2O at 20° C	19.1	18.9
SiO_2	1.11	.55	Solution in H_2O at 100° C	96.5	95.9
SO_3	2.65	.264	Protein in alcohol precipitate	.94	1.30
P_2O_5	.056	.048	CC excess N HCl per gram agar	.034	.024
As_2O_3	(–)	(–)			

Agar-agar has been put to many uses, the number of which is increasing from year to year. It has long been esteemed in China and Japan as a food. It is employed in the preparation of jellies, thickening of soups, ice cream, fruits, meat, or fish, and in candy making. In this country it is used most extensively in hospitals and in bacteriological laboratories. As a base for culture media it is unexcelled by any other substitute, since it remains solid with a smooth, firm surface at the higher temperatures required for cultivating certain species of bacteria. Other jellies are useless because they melt under the requisite conditions. Recently it has been found to possess considerable therapeutic value in the cure of chronic constipation. Its action is dependent on the fact that it has the property of absorbing and holding water, becoming at the same time a lubricant and mild mechanical stimulant, affected but little by the digestive enzymes. The action is not violent as with ordinary cathartics, and it leaves no harmful aftereffects. It has also been found a valuable dressing for certain types of wounds. Emulsions for photographic plates much superior to the ordinary gelatin emulsions are claimed to have been made.

AGAR-AGAR RESOURCES OF THE UNITED STATES.

A recent very incomplete survey of American seaweeds that yield gelatin has brought to light another one of our valuable natural resources that has been totally neglected. Up to the present time we have been importing agar-agar, an essential product to our general welfare, from countries thousands of miles distant, when a superior product is to be had, probably for less cost, from algæ growing on our own shores. Even should the cost of production prove to be more than that of the imported product, it is important, as a step toward national security, to develop domestic sources of supply. Of a dozen or more species of algæ on the California coast supposed to yield gelatin, the writer has been able to examine four with the following results:

GELIDIUM CARTILAGINEUM.

The species *Gelidium cartilagineum* was reported by an agent of the Bureau of Fisheries as growing in abundance on the California

coast from the shores of San Luis Obispo County southward and on the west coast of Lower California.

The amount of dry gelatin which can be extracted from this species is from 40 to 45 per cent of its weight when dried in the sun and air, and the quality seems to be equal to that of the best agar-agar.

A 2 per cent solution of this dried extract will form a hard elastic gel with a smooth surface which remains firm at temperatures below 50° C. Furthermore, when in hot solution it has a comparatively low viscosity, and hence can be filtered and clarified with little difficulty.

To get a pure, translucent extract it is necessary to beat the dry seaweed, wash it in fresh water, and dry it in direct sunlight daily for a week or more. Rain apparently does not harm but rather helps not only in the bleaching process but in the extraction of the undesirable soluble matter. A thorough washing in fresh water before extraction begins will result in making the final product of best quality. A sample of this extract was tested at the Army Medical School and pronounced a satisfactory substitute for the imported agar-agar.

GELIDIUM AMANSII.

A small quantity of *Gelidium amansii* was found mixed in with the sample of *G. cartilagineum* received from the Pacific coast. This was sufficient for one test only, which yielded 28.93 per cent dry gelatin calculated on the weight of the sundried weed.

The properties of this extract are very similar to that of the preceding species and agar-agar. A 2 per cent solution makes a hard, elastic jelly as good as that prepared from regular agar. A sample of the jelly placed on a water bath remained hard at 58° C. and did not begin to liquefy until it had reached a temperature of 76° C.

A single fat determination made by the Soxhlet method gave 0.195 per cent, which means that the weed is practically fat free.

GELIDIUM AUSTRALE.

Two small samples of *Gelidium australe* which were extracted yielded 32.3 per cent and 37.5 per cent of dry gelatin, respectively. The fat content of water-free samples varied between 0.25 per cent and 0.405 per cent.

A 2 per cent solution makes a firm gel, but since it becomes soft and mushy at 40° C. it is an unsatisfactory substitute for agar-agar. It may, however, prove to be a valuable product for such purposes as carrageenin is now used.

ENDOCLADIA MURICATA.

Another seaweed from the California coast which readily yielded a large supply of gelatinous extract is *Endocladia muricata*. It yields from 37.5 to 48 per cent of gelatin.

The properties of the Endocladia jelly are much like that of the Irish moss, in that it is very viscous when hot, rather soft when cold, and has a low melting point. This renders it unfit for use as a substitute for agar-agar. As a size or an ingredient of water paints

it promises to be a valuable product. It may possibly find use in the preparation of certain food products.

A small sample of an unidentified seaweed just received from Key West, Fla. (1920), yields a large amount of a soft, transparent, very elastic jelly, very different from any of the jellies examined so far. Quantitative determinations and a study of its properties have not been made.

ALGINIC ACID.

The examination of a large number of seaweeds brought out the general conclusions (1) that the gelatinous products related to gelose are confined to the group of red seaweeds; (2) that the green seaweeds yield little or no gelatinous products, and (3) that the brown algæ produce a gelatinous substance very different from gelose. The gelatinous principle of the brown algæ is known as alginic acid or algin, and was first isolated from the kelp Laminaria by E. C. C. Stanford (Journal of the Society of Chemical Industry, Vol. III, No. 5, 1884, pp. 297–303; Vol. IV, No. 9, 1885, pp. 518–520, 595; and Journal of the Society of Arts, Vol. X, No. 481, 1862, pp. 185–199). His method was to macerate the dried kelp in water to remove the water soluble matters, which amount to about one-third of the dry weed. The insoluble residue contains in part the alginic acid which is rendered soluble by digestion in a hot dilute solution of sodium carbonate. It dissolves out as sodium alginate. This is filtered out with difficulty, and the alginic acid is precipitated by treating the filtrate with hydrochloric acid. The precipitate separates out as an amorphous substance of light amber color, which is washed and bleached. When dry the alginic acid resembles albumen or horn. It is insoluble in either cold or hot water.

Soluble algin or sodium alginate is produced when alginic acid is allowed to react with a solution of sodium carbonate. According to Stanford, a solution of soluble algin has 14 times the viscosity of starch and 37 times that of gum arabic. The alginic acid is precipitated from the solution of its sodium salt by most mineral acids and by picric, oxalic, tartaric, and citric acids. A 2 per cent aqueous solution becomes semisolid when acidulated with hydrochloric acid. Insoluble alginates are formed with most metallic salts, some of them being of curious composition.

Soluble algin differs from gelose by containing nitrogen and not gelatinizing on cooling.

Because of its property of combining with various elements with the production of numerous compounds possessing various degrees of solubility and viscosity, alginic acid promises to become an important commercial product used in the preparation of waterproof fabrics and of pastes for the thickening of colors in the printing and sizing of cloth.

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TRADE IN FRESH AND FROZEN FISHERY PRODUCTS AND RELATED MARKETING CONSIDERATIONS IN SEATTLE, WASH.[1]

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CONTENTS.

INTRODUCTION.

This report of the results of the Seattle market survey constitutes the fifth of a series of fish-trade reports issued by the bureau. Those already published are for Louisville, Ky.; Pittsburgh, Pa.; Chicago, Ill.; and Minneapolis and St. Paul, Minn. In each of these previous reports precedence has been given to local consumption. In this report, however, since Seattle is in the strict sense of the word the first primary market for which a survey has been undertaken, the predominant consideration has been given to production and distribution.

POPULATION, 1920.

The population of Seattle, Wash., according to the 1920 census, was as follows:

Native white	228,705
Foreign-born white	73,875
Japanese	7,874
Negro	2,894
Chinese	1,351
All others	613
Total	315,312

IMPORTANCE AND GROWTH.

Seattle occupies a unique place among the primary fresh and frozen fish markets of the country. As a distributing center it is

[1] Appendix VII to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 930.

the most important on the Pacific coast and as a fishing port is exceeded only by Boston and Gloucester, Mass. In quantity of fish handled, its growth has been unusual, increasing fourfold in the past 25 years. From landings in 1895, amounting to less than 12,000,000 pounds, the industry has grown until to-day the annual arrivals run in excess of 45,000,000 pounds. Even greater than its increase in quantity received has been its increase in rail shipments, which at present are almost seven times what they were 25 years ago. In 1895 the quantity reshipped from Seattle by rail amounted to 4,252,000 pounds, or 37 per cent of the total quantity received, while in 1921 the quantity reshipped by rail amounted to 28,612,000 pounds, or 63 per cent of the quantity received, an increase of 26 per cent in the proportion reshipped, in spite of a large increase in consumption within the city itself.

COMMERCIAL SPECIES OF FISH.

TRADE NAMES.

A nomenclatural conflict exists in this market, as in others, so the following explanatory list is included for the reader's guidance.

Standard and local names of species of fish sold.

Name used in tables.	Local names.
Halibut	Halibut or flatfish, graded as follows: Whale, when weight exceeds 90 pounds; medium, when meat is blue and weight ranges from 10 to 90 pounds; No. 2, when meat is white or mushy; and chicken, when weight is less than 10 pounds.
Salmon	Five species, named as follows: Chinook, spring, king, tyee, blackmouth, or quinnat; sockeye, blueback, or quinault; silver, coho, or silverside; pink, humpback, or humpy; chum or dog.
Flounder	Flounder, flatfish, or sole.
Eulachon	Eulachon or Columbia River smelt.
Red rockfish	Red snapper.
Black rockfish	Rock cod.
Sablefish	Sablefish, black cod, or skilfish.
Squid	Squid or inkfish.
Octopus	Octopus or devilfish.
Clams, hard	Butter clam or little neck.

IMPORTANT SPECIES.

Salmon and halibut constitute the backbone of the Seattle trade, the combined landings of these two species during 1921 amounting to slightly over 83 per cent of all fresh and frozen fishery products reaching this market. Of this amount 44 per cent is credited to salmon and 39 per cent to halibut.

Aside from halibut and salmon, several other species are of consequence, some of which have come into prominence within very recent years. Perhaps the most notable of these is the sablefish, or black cod, the out-of-town demand for which has dropped off materially since the war period, at which time its sale attained considerable proportions. In the local market, however, sablefish is considered a steady seller and finds particular favor among the Scandinavian population. Smelts, red rockfish, and filleted fish are also regarded as regular sellers in the city proper.

The shellfish branch of the trade is of considerable volume in itself. Approximately 50,000 dozen crabs are handled yearly, over three-fourths of which are reshipped to coastal cities. Although shipments of this excellent sea food have gone through to New York in fair condition, there is but a negligible amount shipped to eastern markets. Hard-shell clams, from the standpoint of quantity received, rank second among the shellfish. Local channels absorb 50 per cent of the quantity handled, and coastal cities, principally those of California, purchase the remainder. Shrimp meat, arriving mainly from Wrangell and Petersburg, Alaska, is frozen at Seattle and held for the demands of the trade. A small quantity, about 5 per cent of the total amount sold, is received unshelled from local points. The height of the trade in eastern oysters extends from October to March, and in quantity used surpasses that of the native oyster by a ratio of about two to one.

Species of fish that constitute over 90 per cent of the trade, Seattle, Wash.

Species.	Estimated percentage received frozen.	Principal sources of supply.[1]	Principal form in which received.	Usual containers in which received.
Halibut, fresh		Ocean Banks and Alaska.	Dressed with head on.	Vessel's hold and in 500-pound boxes.
Halibut, frozen	15	Alaska[2]	Dressed	330-pound boxes.
Sablefish, fresh		Ocean banks and Alaska.	do	Vessel's hold and in 500-pound boxes.
Sablefish, frozen	10	Alaska	do	335-pound boxes.
Salmon, fresh (including steelhead trout).		Alaska, British Columbia, Oregon, and local points.	Round and dressed	Fishing boats and in odd-sized boxes.
Salmon, frozen	8	Alaska		340-pound boxes.
Smelts		Local points	Round	50-pound boxes.
Red rockfish		Ocean banks	Dressed	Vessel's hold and in 500-pound boxes.
Crabs		Local points	Alive	Boxes, by boat and rail.
Shrimp		Alaska and local points	Cooked; in shells and shelled.	Boxes, by boat.
Oysters, eastern (exclusive of transplants).		Atlantic coast points	Shucked in cans and unshucked.	Express in carload, and l. c. l. lots.[3]
Clams, hard		Local points and British Columbia.	Unshucked	Sacks, by boat.
Filleted fish[4]				

[1] "Local points" is here used to designate points within the State of Washington.
[2] Fish-freezing plants in Alaska are located at Seward, Sitka, Ketchikan, Juneau, and Petersburg.
[3] Shucked oysters arrive in 1 to 5 gallon cans, crated, when in less than carload lots; uncrated, when by carload.
[4] Fillets are made chiefly from halibut (largely chicken), lingcod, flounders, and red rockfish.

SPECIES OF SECONDARY IMPORTANCE.

With the exception of oysters, the group of fresh and frozen fishery products of secondary importance finds favor mainly with the foreign population of the city. According to local dealers the aversion of Americans toward most of the fishes falling into this group is due to the extra pains required in preparing them for cooking. An example of this condition is shown in the case of filleted "lingcod," for which a considerable demand has been built up by several establishments. When sold whole or sliced, however, it is regarded as a comparatively slow seller.

The much esteemed Olympia oyster, which is native of the State of Washington, holds a peculiar position in this market in that it commands a higher price than the eastern oyster shipped here by rail for a distance of over 3,000 miles. The higher cost of the native oyster at home than that of the imported eastern oyster is attributed by men in the trade to greater expense in cultivating and handling, the cost of culling and opening a gallon of native oysters alone being about equal to the selling price of a gallon of eastern oysters on their own seaboard.

Species of fish for which the demand is moderate, Seattle, Wash.

Species.	Principal sources of supply.[1]	Principal form in which received.	Usual containers in which received.
Black rockfish	Local points	Round	Boxes of various sizes.
Blue perch [2]	do	do	Do.
Cod	Ocean banks and local points.	Dressed and round	Fishing boats and boxes of various sizes.
Eulachon	Local points	Round	50-pound boxes.
Flounders	do	do	Boxes of various sizes.
Herring	British Columbia and local points.	do	Fishing boats and boxes of various sizes.
"Lingcod"	Ocean banks and local points	Dressed, head on	Do.
Shad	Local points and Oregon	Round	Boxes of various sizes.
Sturgeon	Ocean banks, local points, and Oregon.	do	Fishing boats and boxes of various sizes.
Tomcod	Local points	do	Boxes of various sizes.
White perch [3]	do	do	Do.
Oysters:			
Native	do	In shell	Sacks, by boat.
"Transplants" [4]	do	do	Boxes, by boat and rail.

[1] "Local points" is here used to designate points within the State of Washington.
[2] One of the surf fishes (*Tæniotoca lateralis*).
[3] One of the surf fishes (*Damalichthys argyrosomus*).
[4] Matured eastern oysters grown on local beds from seed oysters shipped from the Atlantic coast.

SPECIES FOR WHICH DEMAND IS LIMITED.

In the following table it will be noted that the demand for practically half of the species for which there is only a small sale is limited to the oriental trade.

Species of fish for which demand is limited, Seattle, Wash.

Species.	Principal sources of supply.[1]	Reasons given for small sale.
Barracuda	San Pedro, Calif	Restricted chiefly to oriental trade.
Bonito	do	Do.
Carp	Local points and Oregon	Restricted to Jewish and oriental trade.
Chubs [2]	do	Restricted chiefly to oriental trade.
Grayfish	Local points	Demand fallen off; not popular.
Mackerel	San Pedro, Calif	Unpopular.
Sea bass	do	Do.
Tuna	Points in California	Restricted chiefly to oriental trade.
Yellowtail	San Pedro, Calif	Do.
Squid	Points in California	Unpopular.
Octopus	Local points	Restricted to oriental trade.
Shad roe	Local points and Oregon	Supply limited; price considered relatively high.
Shark meat	Local points	Unpopular.
Skate wings	do	Popular principally with southern Europeans.
Clams, razor	Coastal beaches of Washington and Oregon.	Demand limited.
Scallops	Local points	Supply limited.

[1] "Local points" is here used to designate points within the State of Washington.
[2] One of the minnows (*Mylocheilus caurinus*) reaching a length of 12 inches.

CONTAINERS.

Boxes are used as containers where arrivals are not in bulk in the holds of vessels or in gunny sacks. For outgoing shipments boxes are used exclusively.

Size and capacity of containers in which fishery products are received and reshipped, Seattle, Wash.

PRINCIPAL TYPES OF BOXES[1] AND SACKS IN WHICH FISH ARE RECEIVED.

Varieties.	Inside measurements.			Average net contents.
	Length.	Width.	Depth.	
Salmon, sablefish, halibut, rock fishes and cod:	*Inches.*	*Inches.*	*Inches.*	
Fresh....boxes..	54.5	30	15.5	500 pounds.
Frozen....do....	48.5	23.75	17	330 to 340 pounds.
Crabs:				
Puget Sound....do....	40	24	22	20 dozen.
Wilappa Harbor....do....	40	24	13	8 dozen.
Shrimp meat....do....	54.5	30	15.5	320 pounds.
Oysters:				
Eastern "transplants"...do....	19	11.5	11.5	250 shells.
Olympia or native....gunny sacks..	....	....	....	105 to 115 pounds.
Clams, hard....do....	....	....	....	100 pounds.
Scallops....do....	....	....	....	65 pounds.

PRINCIPAL TYPES OF BOXES USED FOR OUTGOING SHIPMENTS.

Varieties.	Length.	Width.	Depth.	Average net contents.
Fresh fish:				
Various species....	48.5	23.75	17	400 pounds.
Do....	42.5	20.5	11.5	200 pounds.
Do....	42	16.5	11.5	150 pounds.
Do....	37.5	15.5	11.5	125 pounds.
Do....	37.5	15.5	9.5	100 pounds.
Do....	28.5	14	9.5	75 pounds.
Do....	28.5	12.75	8.75	50 pounds.
Do....	25.5	10.75	7.75	40 pounds.
Do[2]....	21.5	10.75	7.75	25 pounds.
Frozen fish:				
Salmon, single....	26	7	6.5	8 to 10 pounds.
Salmon[3]....	49	24	17.5	340 pounds.
Halibut[3]....	49	24	17.5	330 pounds.
Shellfish:				
Hard clams, oysters, and shrimp.	13	11.5	9	25 pounds of clams, 10 pounds of shrimp meat in cans, or from 1 to 2 gallons of oysters in cans.
Hard clams, oysters, and crabs.	18	12	9	50 pounds of clams, 1 dozen crabs, or 3 gallons of oysters in cans.
Hard clams, oysters, and shrimp.	19	12.5	11.5	75 pounds of clams, 25 to 30 pounds of shrimp meat in cans, or from 4 to 5 gallons of oysters in cans.
Hard clams, oysters, and crabs.	18	18	11.5	100 pounds of clams, 2 dozen crabs, or from 5 to 7 gallons of oysters in cans.
Crabs and shrimp....	24	19	12	50 pounds of shrimp meat or 3 dozen crabs.
Do....	32	19	12	75 pounds of shrimp meat in cans or 4 dozen crabs.
Do....	40	19	13	100 pounds of shrimp meat in cans or from 5 to 6 dozen crabs.

[1] Numerous other types of boxes approaching no standard size are also used.
[2] This and above boxes have a ¾-inch hole bored in each end as a receiver for hooks to facilitate handling.
[3] These boxes are paper lined.

SOURCES OF SUPPLY AND FISHERY PRODUCTS RECEIVED.

The local designation and delineation of the four general supply areas referred to in the statistical tables contained in this report may be defined as follows: (1) "Outside fishing areas," restricted almost entirely to ocean banks extending from the southern boundary of

Oregon to Portlock bank, Alaska; (2) "Puget Sound," comprising Puget Sound proper, together with the Strait of Juan de Fuca, Rosario Strait, Canal de Haro and adjacent bays, straits, and sounds; (3) "Alaska," including principally boat shipments from Alaskan ports, exclusive of direct landings of fishing vessels operating off the coast of Alaska; and (4) "British Columbia," including mainly boat and rail arrivals exclusive of direct landings of fishing vessels operating off the coast of British Columbia. These areas overlap in a number of instances, but the limits described are as definite as the scope of the field permits.

Quantity of certain fresh and frozen fishery products received at Seattle, Wash., during 1921.

[Thousand pounds (000) omitted.]

Species and source of supply.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
HALIBUT.													
Alaska	148	324	384	454	310	366	606	562	410	510	590	628	5,292
Outside fishing areas	410	564	690	1,112	1,660	1,604	1,602	1,670	1,256	690	466	372	12,096
British Columbia	26	110	24	26	38	4	......	......	......	16	40	56	340
Total	584	998	1,098	1,592	2,008	1,974	2,208	2,232	1,666	1,216	1,096	1,056	17,728
SALMON.													
Alaska	86	68	82	166	446	522	614	172	194	40	336	54	2,780
Outside fishing areas	28	......	10	......	6	92	156	190	88	10	10	......	590
British Columbia	70	116	248	250	488	580	872	848	1,334	132	62	14	5,014
Puget Sound fishing areas	138	......	......	......	617	753	2,199	2,898	1,750	3,126	......	......	11,481
Total	322	184	340	416	1,557	1,947	3,841	4,108	3,366	3,308	409	68	19,866
MIXED FISH.[1]													
Alaska	18	38	2	......	8	6	358	38	46	10	128	20	672
Outside fishing areas	22	76	76	120	64	122	172	1,236	764	440	78	14	3,184
British Columbia	42	46	26	24	28	2	......	......	......	6	......	10	184
Puget Sound fishing areas	202	342	191	156	57	47	52	91	66	72	130	221	1,627
Total	284	502	295	300	157	177	582	1,365	876	528	336	265	5,667
CRABS.													
Puget Sound and local points	130	95	123	126	86	51	49	......	......	130	144	161	1,095
SHRIMP.													
Alaska and local points	17	32	13	8	14	16	15	21	13	15	38	24	226
OYSTERS, SCALLOPS, AND CLAMS.[2]													
Atlantic coast, local points, and British Columbia	......	......	......	......	......	......	......	......	......	......	......	......	664

[1] Includes sablefish, gray cod, tomcod, "lingcod," rock fishes, flounders, smelts, perch, herring, etc.
[2] For table of oyster arrivals see page 7.

CARLOAD ARRIVALS OF OYSTERS.

Oysters in carload quantities were received in Seattle during 1921 from points in Connecticut, Massachusetts, New York, and Virginia. The oysters all arrived by express and were received only in the months shown in the following table:

Express carload arrivals of oysters at Seattle, Wash., during 1921.

Point of origin.	Number of cars unloaded during 1921.					
	January.	February.	October.	November.	December.	Total.
Connecticut: South Norwalk	2	1	1	1	3	8
Massachusetts: Boston	1					1
New York: New York City				2		[1] 2
Virginia: Keller					2	[2] 2
Total	3	1	1	3	5	13

[1] Of this number 1 was opened at Spokane, Wash.
[2] Opened at Spokane, Wash.

RESHIPMENT OF FISHERY PRODUCTS.

Consuming locally but a fractional part of its landings of fresh and frozen fishery products, Seattle is dependent upon distant markets for the greater part of its business. To these markets the principal carrier is the railroad, the quantity leaving Seattle by rail during 1921 amounting to 28,612,000 pounds, as against 1,166,000 pounds shipped by boat during the same period. Less-than-carload shipments are made by express and are largely confined to cities located west of Omaha, Nebr.; 92 per cent of the carload shipments are consigned to cities east of Omaha. This division also roughly represents the boundary between what may be termed the steady and the surplusage market in that the former corresponds to the area of less-than-carload shipments and the latter to the area of carload shipments.

The following table shows, by months, shipping agency, and certain destinations, the number of thousands of pounds of fresh and frozen fish shipped from Seattle during 1921:

Quantity of fresh and frozen fishery products shipped from Seattle, Wash., to certain destinations during 1921.

[Thousand pounds (000) omitted.]

Shipping agency and destination.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Shipped by boat to—													
Alaska	22	46	20	60	52	20	60	78	54	38	28	24	502
British Columbia	46	86	10	6	6	40	40	82	4	32	126	6	[1] 484
California	10		8										[2] 18
Great Britain		110										20	130
Hawaiian Islands								6	4	8	4	10	32
Shipped by rail to—													
Points in United States and Canada [3]	3,060	4,210	1,609	2,218	2,110	1,988	2,009	2,256	2,120	2,744	1,937	2,345	28,612
Total	3,138	4,452	1,647	2,284	2,168	2,048	2,109	2,422	2,182	2,822	2,095	2,405	29,778

[1] Includes 41 tons of halibut, 13 tons of salmon, and 188 tons of miscellaneous fish.
[2] Oysters.
[3] Combined c. l. and l. c. l. shipments of all species. For detailed table of carload shipments see p. 9.

Short-line travel distance and freight and express rates on fresh and frozen fish from Seattle, Wash., to principal distributing centers.

Destination.	Short-line travel distance in miles.	Rate in cents per 100 pounds.			
		C. l. freight.	L. c. l. freight.	C. l. express.[1]	L. c. l. express.[2]
California: San Francisco	955	[3] 221 [6] 109½	155	221	[4,5] 207 262
Colorado:					
Denver	1,559	[3] 359 [7] 175½	406½	359	455
Pueblo	1,678	[3] 359 [7] 175½	406½	359	455
District of Columbia: Washington	2,985	[3] 428 [7] 250	616½	428	788
Illinois: Chicago	2,198	[3] 393 [7] 208½	566½	393	595
Indiana: Indianapolis	2,382	[3] 428 [7] 250	583½	428	621
Iowa:					
Des Moines	2,055	[3] 393 [7] 208½	550	393	595
Sioux City	1,860	[3] 359 [7] 208½	500	359	499
Kansas: Wichita	2,172	[3] 359 [7] 208½	500	359	512
Maryland: Baltimore	2,995	[3] 428 [7] 250	616½	428	788
Massachusetts: Boston	3,231	[3] 428 [7] 250	616½	428	788
Minnesota:					
Minneapolis	1,774	[3] 359 [7] 208½	500	359	512
St. Paul	1,784	[3] 359 [7] 208½	500	359	512
Missouri:					
Kansas City	2,050	[3] 359 [7] 208½	500	359	512
St. Louis	2,328	[3] 393 [7] 208½	550	393	595
Montana: Butte	668	[3] 290 [7] 167½	281½	[8] 290	385
New York:					
Buffalo	2,723	[3] 428 [7] 250	616½	428	788
Cape Vincent	2,969	[3] 428 [7] 250	616½	428	788
New York	3,107	[3] 428 [7] 250	616½	428	788
Nebraska: Omaha	1,909	[3] 359 [7] 208½	500	359	512
North Dakota: Fargo	1,587	[3] 359 [7] 208½	500	359	512
Oregon: Portland	183	[6] 45	75	....	[4] 156
Ohio:					
Cincinnati	2,483	[3] 428 [7] 250	583½	428	678
Cleveland	2,555	[3] 428 [7] 250	600	428	736
Sandusky	2,497	[3] 428 [7] 250	600	428	736
Pennsylvania:					
Erie	2,650	[3] 428 [7] 250	600	....	761
Philadelphia	3,015	[3] 428 [7] 250	616½	428	788
Pittsburgh	2,666	[3] 428 [7] 250	600	428	761
Utah:					
Ogden	1,034	[9] 167½	284½	359	398
Salt Lake City	1,071	[9] 167½	284½	359	398
Washington: Spokane	309	[10] 92½	155	....	[4,11] 218
Wisconsin: Milwaukee	2,113	[3] 393 [7] 208½	566½	393	595

[1] All carload express rates are subject to the following: Weight basis applicable, net weight, subject to minimum weight of 20,000 pounds, except when cars of less capacity than 2,050 cubic feet are furnished at carrier's convenience, minimum weight of 15,000 pounds will apply. Initial icing, $6.93 per 2,000 pounds; minimum charge, $27.72 per car.

[2] All less than carload express rates are subject to the following, unless indicated by reference mark: Minimum charge, $0.34 per shipment; weight basis, 25 per cent added to the net weight of the fish, unless actual gross weight is less at time of shipment; refrigeration, ice to be furnished by shipper at owner's expense.

[3] Applies on fish, fish roe, fresh or frozen, carload minimum weight, 20,000 pounds, when forwarded on passenger trains. Refrigeration charges in addition, initial icing to be furnished by shipper, or, if supplied by carrier, will be charged for at rates of $6.93 per 2,000 pounds; minimum charge, $27.72 per car. Also reicing in transit will be charged for at rates varying with points at which furnished.

[4] Same as Note 2, except no minimum charge of $0.34 per shipment.

[5] In lots of 1,000 pounds or more.

[6] Carload minimum weight, 24,000 pounds.

[7] Fresh fish, packed in ice, will be billed and charges collected thereon at gross weight of fish, including the packages (less 6,000 pounds for ice), subject to minimum carload weight of 30,000 pounds.

[8] No unloading in transit allowed between point of origin and destination.

[9] Fresh fish, packed in ice, will be billed and charges collected thereon at gross weight of fish, including the packages (less 6,000 pounds for ice), subject to minimum carload weight of 20,000 pounds.

[10] Carload minimum weight, 20,000 pounds.

[11] Rate quoted from tariffs on file but can not be vouched for if shipment moves "intrastate."

CARLOAD SHIPMENTS.

Statistical records dating back to 1895 show that 82 carload shipments of fish were made from Seattle during that year. Last year more than seven times this number were dispatched. Of the 635 carloads shipped during the past year over half were consigned to but four cities, namely: Chicago, New York, Kansas City, and Boston. Under the tariff provision permitting the opening of certain cars of fish en route to final destination 227 of the cars shipped in 1921 were so opened, while 408 were shipped direct to final destination.

Carloads of fresh and frozen fish shipped from Seattle, Wash., during 1921, by destinations and months.

Destination.	January.		February.		March.		April.		May.		June.		July.	
	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.
DOMINION OF CANADA.														
British Columbia: Vancouver			1											
Ontario: Toronto					1									
UNITED STATES.														
California: San Francisco	3		2		3		4							
Colorado:														
Denver	2		1		1									
Pueblo														
District of Columbia: Washington														
Illinois: Chicago	6	2	7	3	5	3	9	5	15	5	5	4	1	8
Indiana: Indianapolis														
Iowa:														
Des Moines														
Sioux City			1		1									
Kansas:														
Dodge City														
Wichita	1		1											
Kentucky: Louisville														
Maryland: Baltimore	4		1											
Massachusetts: Boston	5	1	4						4	1	6	5	5	2
Minnesota:														
Duluth														
Minneapolis	3		4		1									
St. Paul	3				1				1					
Missouri:														
Kansas City	9		5		2	1	1	5		7		8	3	4
St. Louis	6		1		1			2		3		3		1
Montana: Butte			1											
New York:														
Buffalo			1							1		3		6
Cape Vincent														
New York	6	1	6		3	3	7	2	7	5	7	6	9	7
St. Johns Park														
Nebraska: Omaha	2		2	1	1	2		4		4		3		5
North Dakota: Fargo														
Oregon: Portland	3	1	1											
Ohio:														
Cincinnati					1									
Cleveland	2					1								
Sandusky			1											
Pennsylvania:														
Erie														
Philadelphia	1													
Pittsburgh	5		1									1		
Utah:														
Ogden	1													
Salt Lake City	1		2											
Washington: Tacoma											1			
Wisconsin:														
Green Bay	2													
Milwaukee	1													
Total	66	4	43	4	21	10	21	18	27	26	19	33	18	33

Carloads of fresh and frozen fish shipped from Seattle, Wash., during 1921, by destinations and months—Continued.

Destination.	August.		September.		October.		November.		December.		Total.		Grand total.
	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	Through.	Opened en route.	
DOMINION OF CANADA.													
British Columbia: Vancouver	....	....	....	....	....	....	....	....	....	....	1	.....	1
Ontario: Toronto	....	....	....	....	....	....	....	....	....	....	1	.....	1
UNITED STATES.													
California: San Francisco	....	....	....	....	....	....	....	....	2	....	14	.....	14
Colorado:													
Denver	....	....	....	....	2	1	....	....	2	....	8	[1] 1	9
Pueblo	....	....	....	....	....	1	....	....	....	....	....	[2] 1	1
District of Columbia: Washington	....	....	....	....	....	....	1	....	....	....	1	.....	1
Illinois: Chicago	3	4	7	....	19	2	6	4	4	....	87	[3] 40	127
Indiana: Indianapolis	....	....	....	....	1	....	1	....	....	....	2	.....	2
Iowa:													
Des Moines	....	....	....	....	1	....	....	....	....	....	1	.....	1
Sioux City	....	....	....	....	1	....	1	....	....	....	4	.....	4
Kansas:													
Dodge City	....	....	....	....	....	....	1	....	....	....	1	.....	1
Wichita	....	....	....	....	....	....	....	....	....	....	2	.....	2
Kentucky: Louisville	....	....	....	....	1	....	....	....	....	....	1	.....	1
Maryland: Baltimore	....	....	....	....	2	....	....	....	4	....	11	.....	11
Massachusetts: Boston	11	3	10	2	3	1	....	....	4	1	52	[4] 16	68
Minnesota:													
Duluth	....	....	....	....	....	....	....	....	1	....	1	.....	1
Minneapolis	....	....	....	....	3	....	3	....	3	....	17	.....	17
St. Paul	....	....	1	....	6	....	....	....	1	....	13	.....	13
Missouri:													
Kansas City	2	4	1	9	7	5	3	....	5	1	38	[5] 44	82
St. Louis	....	7	1	3	3	3	2	....	3	....	17	[6] 22	39
Montana: Butte	....	....	....	....	....	....	1	....	1	....	2	.....	2
New York:													
Buffalo	....	5	1	4	1	4	1	....	2	....	6	[7] 23	29
Cape Vincent	....	....	....	....	....	....	1	....	....	....	1	.....	1
New York	7	7	6	2	4	1	2	....	3	....	67	[8] 34	101
St. Johns Park	....	....	....	....	....	....	....	....	1	....	1	.....	1
Nebraska: Omaha	....	8	....	7	5	4	....	2	1	2	11	[9] 42	53
North Dakota: Fargo	....	....	....	....	....	....	1	....	....	....	1	.....	1
Oregon: Portland	....	....	....	....	....	....	....	....	1	....	5	.....	5
Ohio:													
Cincinnati	....	....	....	....	4	....	3	....	....	....	8	.....	8
Cleveland	....	....	....	....	....	....	....	....	....	....	2	[10] 1	3
Sandusky	....	....	....	....	....	....	1	....	1	....	3	.....	3
Pennsylvania:													
Erie	....	....	....	....	....	....	....	....	1	....	1	.....	1
Philadelphia	....	....	....	....	....	....	....	....	....	....	1	.....	1
Pittsburgh	....	....	....	1	1	....	....	....	3	....	10	[11] 2	12
Utah:													
Ogden	....	....	....	....	....	....	....	....	....	....	1	.....	1
Salt Lake City	....	....	....	....	2	....	....	....	1	....	6	.....	6
Washington: Tacoma	....	....	....	....	....	....	....	....	....	....	1	.....	1
Wisconsin:													
Green Bay	....	....	....	....	1	....	4	....	1	....	8	.....	8
Milwaukee	....	1	....	....	....	....	....	....	....	....	1	[12] 1	2
Total	23	39	27	28	67	22	32	6	44	4	408	227	635

[1] Opened at Salt Lake City, Utah. [2] Opened at Denver and Colorado Springs, Colo.

[3] Of this number, 4 cars were opened at St. Paul, Minn., and Milwaukee, Wis.; 2 at Milwaukee, Wis.; 4 at St. Paul, Minn.; 3 at Omaha, Nebr.; 12 at Fargo, N. Dak., and St. Paul, Minn.; 8 at Denver, Colo., and Omaha, Nebr.; 3 at Minneapolis and St. Paul, Minn.; 1 at Fargo, N. Dak.; and 3 at Minneapolis, Minn.

[4] Of this number, 5 cars were opened at Chicago, Ill.; 2 at Milwaukee, Wis., and Chicago, Ill.; 1 at Fargo, N. Dak., and St. Paul, Minn.; 1 at Omaha, Nebr.; 4 at Buffalo, N. Y.; 2 at Fargo, N. Dak., and Chicago, Ill.; and 1 at St. Paul, Minn., and Chicago, Ill.

[5] Of this number, 14 cars were opened at St. Paul, Minn., and Omaha, Nebr.; 1 at St. Paul, Minn.; 1 at Fargo, N. Dak., and Omaha, Nebr.; 3 at St. Paul, Minn., and Sioux City, Iowa; 1 at Fargo, N. Dak., and St. Paul, Minn.; 19 at Denver, Colo.; 1 at Sioux City, Iowa, and Omaha, Nebr.; 3 at Salt Lake City, Utah, and Denver, Colo., and 1 at Omaha, Nebr.

[6] Of this number, 6 cars were opened at Chicago, Ill.; 5 at Milwaukee, Wis., and Chicago, Ill.; 2 at Sioux City, Iowa, and Kansas City, Mo.; 1 at St. Paul, Minn., and Chicago, Ill.; 2 at St. Paul, Minn.; 3 at Salt Lake City, Utah, and Denver, Colo.; 3 at Omaha, Nebr., and Kansas City, Mo.

[7] Of this number, 1 car was opened at St. Paul, Minn., and Cleveland, Ohio; 3 at Chicago, Ill., and Cleveland, Ohio; 16 at St. Paul, Minn., and Chicago, Ill.; 1 at Omaha, Nebr., and Chicago, Ill.; 1 at Cleveland, Ohio; and 1 at Denver, Colo.

[8] Of this number, 11 cars were opened at Buffalo, N. Y.; 3 at St. Paul, Minn., and Chicago, Ill.; 5 at Omaha, Nebr.; 2 at Fargo, N. Dak., and St. Paul, Minn.; 1 at Chicago, Ill., and Buffalo, N. Y.; 6 at Chicago, Ill.; 1 at St. Paul, Minn., and Buffalo, N. Y.; 1 at St. Paul, Minn.; 2 at Denver, Colo., and Omaha, Nebr.; 1 at Milwaukee, Wis.; and 1 at Denver, Colo.

[9] Of this number, 1 car was opened at St. Paul, Minn., and Sioux City, Iowa,; 3 at St. Paul, Minn.; 20 at Salt Lake City, Utah, and Denver, Colo.; 1 at St. Paul, Minn., and Fargo, N. Dak.; 17 at Denver, Colo., of which one was partially loaded at Portland, Oreg.

[10] Opened at Chicago, Ill. [11] Opened at Chicago, Ill., and Cleveland, Ohio. [12] Opened at St. Paul, Minn.

MAIL-ORDER BUSINESS.

Four concerns in the city may be classed as doing a strictly mail-order business. A good many other fish houses also sell to a greater or lesser degree by this method, especially during the holiday and lenten seasons, and it is even an important factor with some of the larger wholesalers. The general method of advertising employed by the regular mail-order houses is to circularize certain sections of the country for orders. In these establishments quite a proportion of the business is made up of express shipments of single salmon, the package being iced at the time of shipment by the consignor and re-iced in transit by the carrier. The retail price, which includes transportation charges, averages about $2 delivered to points west of the Mississippi and about $2.25 delivered east thereof. During 1921 approximately 18,000 shipments of single salmon, weighing from 8 to 10 pounds each, were made, some of which were successfully made to Florida. It is alleged by some dealers that much damage has been done to this business by unscrupulous dealers shipping inferior fish.

IMPORTANCE OF SEATTLE FISH IN OUTSIDE MARKETS.

To show the relative importance of Seattle fish in certain outside markets as compared with the other varieties sold in such markets, the following table has been compiled from extracts taken from the senior author's previously issued reports on Louisville, Ky.; Pittsburgh, Pa.; Chicago, Ill.; and Minneapolis and St. Paul, Minn.

Importance of Seattle fish in outside markets.

Species and markets.	Relative importance compared with other varieties sold and opinions of dealers.
Eulachon:	
Pittsburgh, Pa	Sale limited on account of general unpopularity.
Chicago, Ill	Do.
Minneapolis and St. Paul, Minn.	Do.
Flounders: Minneapolis and St. Paul, Minn.	Unpopular except among certain classes; proportionate sale in nearby small towns larger than in Twin Cities.
Halibut:	
Louisville, Ky	Of only moderate importance.
Pittsburgh, Pa	In better demand than any other fish sold here.
Chicago, Ill	Of considerable importance; regarded as a staple.
Minneapolis and St. Paul, Minn.	Do.
"Lingcod":	
Chicago, Ill	Sale limited on account of not being well known.
Minneapolis and St. Paul, Minn.	Sale limited; efforts to increase demand reported unsuccessful.
Rockfishes: Minneapolis and St. Paul, Minn.	Sale limited on account of not being well known.
Sablefish:	
Pittsburgh, Pa	Handled principally in winter in frozen form; sale limited.
Chicago, Ill	Only limited sale when received fresh on account of poor keeping quality; sale in frozen form, although at present limited, shows tendency toward increase.
Minneapolis, Minn	Only limited sale when received fresh on account of poor keeping quality; sale in frozen form at present moderate but demand reported falling off.
Salmon:	
Louisville, Ky	Received from Chicago; sale limited on account of high price; the name "salmon" is also applied here to the pike perches received from Lake Erie for which there is a good demand.
Pittsburgh, Pa	Of moderate importance.
Chicago, Ill	Of considerable importance; sale of lower-grade salmon for chinook charged against many retailers by wholesalers.
Minneapolis and St. Paul, Minn.	Of considerable importance.
Smelt:	
Chicago, Ill	Sale limited; accepted when eastern smelts are not available.
Minneapolis and St. Paul, Minn.	In fair demand until Christmas; eastern smelt preferred.
Crabs: Minneapolis and St. Paul, Minn.	Sale limited on account of high price.

COLD STORAGE.

The city's combined sharp-freezer capacity is upward of 200 tons in a 24-hour period. Two companies engaged in the wholesale fish business operate large cold storages, two general warehouses are equipped with facilities for fish freezing, and the Seattle Port Commission maintains a freezer and storage. These plants are the reservoirs in which a great part of the North Pacific's fish surplusages are frozen and held for foreign and domestic distribution. In addition to the above all wholesale establishments are provided with insulated cold rooms. No regulations obtain in this city as to the length of time fish shall be allowed to remain in storage, which in most instances is comparatively brief.

The following table shows the number of pounds of the different varieties of fish in storage at the beginning of the year, the number of pounds frozen, received frozen, and withdrawn during the year, and the number of pounds on hand at the end of the year, for the year ended December 15, 1921.

Cold-storage fish record at Seattle, Wash., for year ended December 15, 1921.

Name.	On hand at beginning of year.	Frozen during year.	Received frozen during year.	Withdrawn during year.	On hand at end of year.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Salmon	3,949,982	6,156,292	780,319	6,209,562	4,677,034
Halibut	3,818,648	3,637,979	724,446	6,137,484	2,043,589
Sablefish	460,796	1,401,700	222,790	946,489	1,138,797
Herring [1]	1,630	121,370	109,435	225,287	7,148
Smelts	19,444	97,886	530	82,404	35,456
Cod	48,010	55,716	2,685	92,781	13,630
Shad	7,145	30,762		12,632	25,275
Rockfishes	54,014	24,107		60,064	18,057
Mackerel	3,304	6,515		7,364	2,455
Shad roe	233	4,054		3,166	1,121
Sea bass	1,480	1,770		2,748	502
Miscellaneous	121,458	487,347	237,702	572,657	273,850
Total	8,486,144	12,025,501	2,077,907	14,352,638	8,236,914

[1] Frozen herring are used in the halibut fishery for bait.

WHOLESALE AND RETAIL TRADE.

In Seattle the fish business is carried on by 15 wholesale houses, 4 wholesale and retail firms, 48 retail fish markets, 14 peddlers, 4 mail-order houses, and 72 grocery stores and meat markets handling fish part of the week. Fresh and frozen fish are handled by 17 wholesalers, oysters by 12, other shellfish by 14, salt fish by 16, smoked fish by 12, stockfish by 4, and canned fish by 4. In the retail trade fresh and frozen fish are handled by all dealers, oysters by 56, other shellfish by 53, salt fish by 65, smoked fish by 94, canned fish by 22, stockfish by 24, meats by 61, delicacies by 8, and groceries by 20. Stores and meat markets handle fish as a side line.

DIRECTORY OF SEA-FOOD DEALERS.

In the following directory the names of the sea-food dealers in Seattle have been listed alphabetically under the groups designated above; that is, wholesale, wholesale and retail, retail only, mail-order houses, and butchers and grocers handling fish part of the week. The products handled are shown for each group except the last.

Directory of sea-food dealers in Seattle, Wash.

[The following are the symbols in table: C=Commission; D=Distributor; I=Importer; J=Jobber; P=Producer; Pk=Packer; S=Smoker.]

Dealers.	Fish handled.								Other goods.				Symbols.
	Fresh.	Frozen.	Oysters.	Other shell-fish.	Salted.	Smoked.	Canned.	Stock.	Poultry.	Meats.	Delicatessen.	Groceries.	
WHOLESALE ONLY.													
American Sea Food Co., 1527 Railroad Ave.	×	×	....	×	×	....	×	....	....	....	....	....	J, D.
Booth Fisheries Co., foot of Wall St.	×	×	×	×	×	×	×	×	....	....	....	....	J, D, Pk, P, S.
Doremus Fisheries, Bell Street Dock	×	×	....	....	×	....	....	....	....	....	....	....	J, Pk, D.
Haines Oyster Co., Pier 12	....	....	×	×	....	....	....	....	....	....	....	....	J, D.
McCallum-Legaz Fish Co., Pier 12	×	×	....	....	×	....	....	....	....	....	....	....	J, Pk, D.
National Independent Fisheries Co., foot of Lander St.	×	×	×	×	×	×	×	....	....	....	....	....	J, Pk, D, P.
New England Fish Co., Pier 8 [1]	×	×	....	....	....	....	....	....	....	....	....	....	D, P.
Newport Fish Co., Pier A	×	×	×	×	×	×	....	....	....	....	....	....	J, D.
Olsen Fish & Cold Storage Co., Pier 12	×	×	....	....	×	....	....	....	....	....	....	....	J, D, Pk.
Puget Sound Fish Co., foot of Washington St.	×	×	×	×	×	×	....	×	....	....	....	....	J, D.
Ripley Fish Co., Pier 9	×	×	×	×	×	×	....	....	....	....	....	....	J, D, Pk.
San Juan Fishing & Packing Co., foot of Stacy St.	×	×	×	×	×	×	×	×	....	....	....	....	J, D, Pk, S, P.
Sebastian Stuart Fish Co., Spokane Street Dock.	×	×	×	×	×	×	....	....	....	....	....	....	J, D, Pk.
Superior Fish Co., 2621 Railroad Ave.	....	....	....	....	×	×	....	....	....	....	....	....	J, D, Pk.
Whiz Fish Co., 1525 Railroad Ave.	×	×	....	×	....	....	....	....	....	....	....	....	J, D
WHOLESALE AND RETAIL.													
Jackson Fish Co., 511 King St.	×	×	×	×	×	×	....	....	....	....	....	....	
Main Fish Co., 615 Sixth Ave., S.	×	×	×	×	×	×	....	....	....	....	....	....	
Palace Fish & Oyster Co., 819 Railroad Ave.	×	×	×	×	×	×	....	....	....	....	....	....	
Washington Fish & Oyster Co., Grand Trunk Dock.	×	×	×	×	×	×	....	×	....	....	....	....	
RETAIL ONLY.													
Allite Products Co., City Dock	....	....	×	×	....	....	....	....	....	....	....	....	
American Fish Market, Economy Public Market.	×	×	×	×	×	×	×	×	....	....	....	....	
August Fish & Oyster Co., 815 Railroad Ave.	×	×	×	×	×	×	×	×	....	....	....	....	
Augustine & Myer:													
815 First Ave.	×	×	×	×	×	×	×	×	×	×	×	×	
500 Fifteenth Ave.	×	×	×	×	×	×	×	×	×	×	×	×	
1507 Queen Anne Ave.	×	×	×	×	×	×	×	×	×	×	×	×	
1520 Third Ave.	×	×	×	×	×	×	×	×	×	×	×	×	
Calderon, Jos., 134 Westlake Public Market	×	×	×	×	×	×	....	....	....	....	....	....	
Corner Fish Market, First Ave. and Pike St.	×	×	×	×	×	×	....	×	....	....	....	....	
Diamond Fish Market, 1221½ Yesler Way.	×	×	×	×	×	×	....	....	....	....	....	....	
Elliot Fish Market:													
Pine Street Public Market	×	×	×	×	×	×	....	....	....	....	....	....	
South End Public Market	×	×	×	×	....	×	....	....	....	....	....	....	
Eskenazi, M., 1522 Fifth Ave.	×	×	×	×	....	×	....	....	....	....	....	....	
Fishermen's Fish Market, 36 Pike Place, Public Market.	×	×	×	×	....	....	....	....	....	....	....	....	
Gerrish Bros., 1903 Market St.	×	×	×	×	×	×	×	×	×	×	×	×	
Haines & Holt, Cooperative Public Market	×	×	×	×	×	×	....	....	....	....	....	....	
Jack's Fish Market, South End Public Market.	×	×	×	×	×	×	....	....	....	....	....	....	
Japan Fish Market, Jackson Street Public Market.	×	×	×	×	....	....	....	....	....	....	....	....	
Joe's Fish Market:													
107 Nineteenth Ave.	×	×	×	×	....	....	....	....	....	....	....	....	
622 Pine St.	×	×	×	×	×	×	....	....	....	....	....	....	
King Fish Market, 609½ King St.	×	×	×	×	×	×	....	....	....	....	....	....	
Kumamoto Market, 675 Main St.	×	×	×	×	....	....	....	....	....	....	....	....	
Lucky Strike Fish Co., Olympic Public Market.	×	×	×	×	....	×	....	....	....	....	....	....	
M. K. Fish Market, 511 Main St.	×	×	×	×	×	×	....	....	....	....	....	....	
Madison Fish Market, Madison Public Market.	×	×	×	×	×	×	....	....	....	....	....	....	

[1] Did not operate.

Directory of sea-food dealers in Seattle, Wash.—Continued.

Dealers.	Fish handled.								Other goods.				Symbols.
	Fresh.	Frozen.	Oysters.	Other shell-fish.	Salted.	Smoked.	Canned.	Stock.	Poultry.	Meats.	Delicatessen.	Groceries.	
RETAIL ONLY—continued.													
Municipal Fish Market, Pike Place Public Market.	×	×	×	×	...	...	...	...	...	...	...	...	
Northwest Fish Market, 1220 First Ave.	×	×	×	×	...	×	...	...	...	...	...	...	
Olympia Fish & Oyster Co., 14 Corner Market.	×	×	×	×	×	×	...	×	...	...	...	...	
Olympia Fish Market, 1512 Pike Place	×	×	×	×	×	×	...	×	...	...	...	...	
Oriental Fish Market, 506 Main St.	×	×	×	×	×	×	...	...	...	...	...	...	
Pacific Fish Market, 803 First Ave.	×	×	×	×	×	×	...	×	...	...	...	...	
Palmer, George, 417 Pike St.	×	×	×	×	×	×	×	×	...	...	...	...	
Pavish, Lawrence, 2303 Market St.	×	×	×	×	...	...	...	...	...	...	...	...	
People's Fish Market, Pike Place	×	×	×	×	×	×	...	×	...	...	...	...	
Philadelphia Fish Market, No. 10 Sanitary Market.	×	×	×	×	×	×	...	×	...	...	...	...	
Pioneer Fish Market, 5103 Ballard Ave.	×	×	×	×	...	...	...	×	...	...	...	...	
Puget Sound Fish Market, South End Public Market.	×	×	×	×	×	×	...	...	...	...	...	...	
Pure Food Fish Market, 1511 Pike Place.	×	×	×	×	×	×	...	×	...	...	...	...	
Queen City Fish Market, 44 Queen City Market.	×	×	×	×	×	×	...	...	...	...	...	...	
Sanitary Fish Market, Sanitary Public Market.	×	×	×	×	×	×	...	...	...	...	...	...	
Seaboard Fish & Oyster Co., 30 Queen City Public Market.	×	×	×	×	×	×	...	...	...	...	...	...	
Seattle Fish Market, 109 Occidental Ave.	×	×	×	×	...	×	...	...	...	...	...	...	
Sunset Fish Market, 31 Sanitary Market.	×	×	×	×	×	×	×	...	...	...	...	...	
United Fish Market, 713 Railroad Ave.	×	×	×	×	...	×	...	...	...	...	...	...	
Water Front Market, foot of Yesler Way	×	×	×	×	×	×	...	...	...	...	...	...	
Westlake Fish Market, 46 Westlake Market.	×	×	×	×	...	×	...	...	...	...	...	...	
Yesler Fish Market, 901 Yesler Way	×	×	×	×	...	×	...	...	...	...	...	...	
Yesler Way Grocery and Fish Market, 725 Yesler Way.	×	×	×	×	×	×	...	...	...	...	...	×	
MAIL ORDER.													
Hamilton, Andrew, Seaboard Bldg.	×	×	...	...	×	×	...	...	...	...	...	...	
Norway Pacific Fish Co., Bell Street Dock.	×	×	...	...	×	×	...	...	...	...	...	...	
Pacific Salmon Co., Pier 1	×	×	...	...	×	...	...	...	...	...	...	...	
Ocean Fisheries Co., 1529 Railroad Ave.	×	×	...	...	...	...	...	...	...	...	...	...	

SEATTLE BUTCHERS AND GROCERS HANDLING FISH PART OF THE WEEK.

Alki Market and Grocery, 5902 Admiral Way.
Arrow Market, 201 Eastlake Ave.
Barbours Market, 2701 Beacon Ave.
Becker Bros., 8421 Greenwood Ave.
Belleview Market, 239 Belleview St.
Biles, W. E. & Co., 2136 and 2660 California Ave.
Boylston Meat Market, 608 East Denny Way.
Brooklyn Market, Fortieth and Brooklyn Ave.
California Avenue Grocery and Market, 6501 California Ave.
Capitol Hill Market, 426 Fifteenth Ave.
City Hall Market, 612 Third Ave.
Columbia Meat Market, 4861 Rainier Ave.
Courage Bros., 816 Union St.
Eastern Market, 605 Eastlake Ave.
Empire Market, 614 Broadway.
Ferry Market and Grocery, 1321 Harbor Ave.
Fussy Market, 905 James St.
Garfield and Eastlake Market and Grocery, 1600 Eastlake Ave.
Green Lake Market, 304 East Sixty-fifth St.
Happy Home Market, 3817 Seventeenth Ave. SW.
Harrah Bros., 621 North Broadway and 903 Nineteenth Ave., N.
Harvard Meat Market, 204 Broadway.
Herretts Grocery, 2601 California Ave.
High School Market, 721 East Pike Place.
Interlaken Meat Market, 2306 Twenty-fourth Ave., N.
Junction Meat Market, 4218 West Alaska St.
Kenwood Market, 2104 North Fifty-fifth Ave.
Lake View Market, 3318 East Cherry St.
Madison Park Market, 4220 East Madison St.
Madison Street Market and Grocery, 1019 East Madison St.
Madrona Market, Thirty-fourth and East Union Sts.
Maple Leaf Market, 7308 Woodlawn Ave.
Middleton Market, 1826 Sixth Ave., W.
Miller's Meat Market, 5257 Fourteenth Ave., NW.
Minot Market, 7956 East Green Lake Way.
Mount Baker Meat and Grocery Co., 2415 Jackson St
Mount Baker Market, 2807 Mount Rainier Drive.
Nelson's Market, 4861 Rainier Ave.
New College Market, 4301 University Way.
North Broadway Market, 226 Broadway, N.
North End Meat Market, 7321 Greenwood Ave.
Northfield Market, 4254 Fremont Ave.
Pearl Market, 5621 Fourteenth St., NE.
Peterson's Market and Grocery, 5904 California Ave.
Phillips Market, 4557 California Ave.
Pioneer Market and Grocery, 2306 California Ave.
Pioneer Market, 4230 Rainier Ave.
Power House Market, 2020 East Madison Ave.
Quality Market, 3938 Wallingford Ave.
Queen Anne Market, 621 Queen Anne Ave.
Reese Bros., 2518 Dearborn St.
Renton Hill Market, 1408 East Pike Place.
Schuman & Busse, 4901 Rainier Ave.

Sennett Grocery and Market, 5507 Duwamish St.
Sound Market, 2209 North Forty-fifth Ave.
Stadium Market, 4509 Fourteenth Ave., NE.
Stevens Meat Market, 119 Madison St.
Stongs Market, 501 Pine St.
Tenth Avenue Market, 2407 Tenth Ave.
Tesack Benson Co., 3203 East Pike Place.
University Grocery and Market, 4755 Fourteenth Ave., N. E.
Valley Meat and Grocery Co., 2739 East Madison St.
Victory Market, 1024 Howell St.
Wallingford Hill Market, 1926 North Forty-fifth Ave.
West Seattle Meat Co., 2354 California Ave.
Wildwood Market, 761 Rainier Boulevard.
Windsor Market, 416 North Thirty-sixth St.
Yesler Way Market, 1732 Yesler Way.
York Grocery, 3404 Rainier Ave.
Youngstown Market, 2601 West Andover St.

RETAIL DISPLAY.

Protection of fishery products displayed in retail markets is largely governed by city ordinance No. 24027, which states, in substance, that all fish on display must be covered with glass or other protective material in such a manner as to exclude, so far as practicable, dust and flies or other insects. In markets handling fish as a major commodity glass-covered cases with tile bottoms are the rule. Refrigeration of display cases is accomplished in 39 establishments by the use of ice alone, in 5 by pipes running through the cases in such a manner as to support trays or platters, and in 4 by the use of both pipes and ice.

The smaller varieties, as well as sliced fish, are displayed on white enameled trays by 4 dealers, on white crockery platters by 5, on granite trays by 9, on white enameled and white crockery platters by 13, on white crockery platters and granite trays by 12, and on white enameled platters, white crockery platters, and granite trays by 5. Of this number 40 dealers also place a portion of their display directly on ice. Added attractiveness is lent fish displays in 27 establishments by garnishes of lettuce, parsley, etc., which makes a very evident appeal to the appetite.

ATTITUDE OF RETAIL MEAT DEALERS HANDLING FISH AS A SIDE LINE.

In Seattle there are 61 retail meat markets carrying fish as a side line. Representing, as these dealers do, over 49 per cent of those coming in direct contact with consumers, their attitude toward the handling of fish is perhaps the best indication of their desire to foster fish trade in their respective communities. Primarily they are interested in the sale of other goods, and according to the statements of a majority of these dealers fish is handled solely to accommodate their customers—a situation also obtaining in a number of other cities, but for which apparently no satisfactory solution has been found. The leading arguments advanced by these dealers, which concur in substance with those advanced by similar dealers in Minneapolis and St. Paul, Minn., may be summed up as follows: (1) The volume of fish business in an individual store does not warrant the exclusive attention of one man, thereby making it necessary for meat cutters to handle fish and meat alternately, which in itself requires repeated washing of hands and detracts from concentration on meat. (2) Considerable time is lost in cleaning fish during rush hours, when quick turnovers in meat are essential. (3) The limited and spasmodic demand for fish causes a material loss through spoilage. (4) The space required for fish could be devoted to meat, which as a single commodity is in better demand.

ATTITUDE AND METHODS OF RETAIL DEALERS HANDLING FISH IN CONJUNCTION WITH OTHER FOODS.

That a consensus of views and methods of retail dealers handling fish in conjunction with other foods might be had, each of the 72 such merchants was asked questions identical with those put to similar dealers in Minneapolis and St. Paul, which are given below, with a summary of the answers received from Seattle dealers.

1. Do you consider fish a profitable side line, or do you handle it only for the convenience of your customers? In answer to this question 27 dealers stated that they considered fish a profitable side line, and 45 stated that they handled fish solely for the accommodation of their customers.
2. What has been the trend of business during the past two years? Has trade decreased, held even, or increased? In answer to which 49 dealers reported a decrease owing to the high price of fish, and 23 reported trade holding even.
3. In your opinion do reductions in meat prices retard the sale of fish? Replies to this question revealed that 19 were of the opinion that reductions in meat prices had no effect whatever on the sale of fish, 20 were of the opinion that reductions in meat prices affect fish buying only among certain classes, and 33 believed that they materially affect the sale of fish.
4. For the purpose of comparing your sales from year to year, etc., do you keep a record of the different kinds of fish sold in your store? Answers to which disclosed that 5 firms kept a comparative record, 26 kept their fish bills separate, and 41 kept no record by which they could accurately determine the number of pounds of the different species sold.

FISHERIES AND MARKET FOR FISHERY PRODUCTS IN MEXICO, CENTRAL AMERICA, SOUTH AMERICA, WEST INDIES, AND BERMUDAS.[1]

Compiled by LEWIS RADCLIFFE,
Assistant in Charge, Division of Fishery Industries.

CONTENTS.

[1] Appendix VIII to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. 931.

INTRODUCTION.

In August, 1921, a questionnaire on the fisheries and market conditions for fishery products was forwarded by the Department of Commerce, through the Department of State, to American consuls in Mexico, Central America, South America, Bermuda, and West Indies. The purpose of the inquiry was to obtain information on the principal local fisheries in each consular district; local methods of preservation and preparation for market; character and value of exports; character, value, and countries of origin of imports; reasons for preference for a particular country's products, such as salmon, sardines, and cod; measures necessary to increase imports from the United States; and reference to literature extant in each district devoted to its fisheries. The replies contained so much information which should prove useful to the trade that it was deemed desirable to include the more important matter in a printed report for the use and guidance of Americans interested in the development of trade with the countries included within the scope of this inquiry. In such a report it is desirable that the facts reported be made known, so that American business may meet any objections raised and may be cognizant of opinions relative to their products.

In some instances consular officers submitted with their reports articles prepared by others familiar with the local fisheries. Considering the large number of contributors and the impracticability of returning revised manuscript to each for examination without greatly delaying the publication of the report, an occasional error, particularly in the statistical matter, may be discovered. In all cases the name of the consul or other contributor is given in connection with the report. A selected bibliography compiled from these reports and other sources is appended for the use of those desirous of obtaining more detailed information on the fisheries of these countries.

During the past year the bureau has issued a series of market surveys on the trade in fresh and frozen fishery products and related marketing considerations in certain of our primary markets, namely, Pittsburgh, Pa.; Louisville, Ky.; Chicago, Ill.; Minneapolis and St. Paul, Minn.; and Seattle, Wash., for the use of the trade in increasing the consumption of fish and as a guide for educational work and the proper conduct of the business.

MEXICO.

MATAMOROS.

[By G. R. Willson, consul, August 17, 1921.]

The only fishery product of the Matamoros consular district consists of several varieties of fresh fish taken from the Gulf of Mexico, about 25 miles distant, by means of seines or hook and line. The fish are preserved by the use of ice and are transported by trucks to Brownsville, Tex., where they are either disposed of locally or shipped to interior points in the United States. Exports of fresh fish to the United States for the period January 1 to June 30, 1921, amounted to 98,375 pounds, valued at $10,000.

The imports of fishery products, consisting of cheap canned salmon and sardines, are entirely from the United States and are practically

insignificant, due to the preference shown for the fresh product. The imports of canned fish for the period January 1 to June 30, 1921, amounted to $1,395. It is not believed that importations of canned, dried, or salt-cured fish can be increased materially until the people have acquired a taste for such products.

NUEVO LAREDO.

[By Edwin B. Adams, vice consul, September 12, 1921.]

There are no fishery products in this consular district. The bulk of the fish imported into this district is during the Lenten season, when approximately 800 boxes (40 pounds each) of the 1-pound fish brick and 300 boxes (40 pounds each) of salt fish are imported, most of which are shipped to other points in Mexico. Due to the Mexican import tariff, practically all of the demand for all kinds of fish in this district is met by the dealers in Laredo, Tex. During the month of August, 1921, 696 pounds of canned fish, valued at $312.31, and 156 pounds of fresh fish, valued at $50.13, were purchased in Laredo, Tex., by the residents of Nuevo Laredo, Mexico.

Following is a statistical report of fish exported through the Laredo (Tex.) customs district for the year ending June 30, 1921. Approximately 85 per cent of these fish passed through the Nuevo Laredo (Mexico) customhouse, and practically the entire volume was consigned to Mexican points other than the Nuevo Laredo consular district:

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Fresh fish	70,366	$11,809	Oysters		$19,836
Cod, haddock, etc	355,493	110,880	Other shellfish		20,664
Herring	7,679	961	Other fish		83,749
Other dried fish	7,702	2,342			
Canned salmon	841,785	77,721	Total		679,500
Canned fish		351,538			

MONTEREY.

[By Thomas D. Bowman, consul, August 25, 1921.]

There are no fisheries in the Monterey consular district. A limited amount of canned and dried fish products is imported into the district, but it is impossible to obtain any statistics regarding the amount. The products imported are sardines, tuna, kippered herring, salmon, fish flakes, and all the standard canned fish products. Dried codfish is also found on the local market. Because of the high cost of these products the market is limited to the wealthier classes. Fresh fish is brought in, iced, from Tampico, Mexico, throughout the year. There is no reexport of imported fish from this district. By far the larger proportion of imported fish products come from the United States. There is an occasional preference for Spanish sardines, based upon particular taste of certain consumers, but the amount of sardines imported from Europe is negligible. It is difficult to increase the imports of fish products into this district because of their high cost.

PIEDRAS NEGRAS.

[By William P. Blocker, consul, August 25, 1921.]

The Piedras Negras consular district is strictly interior, remote from the sea. There is no fishing industry, with the exception of sportsmen fishing for black bass. During various times of the season small amounts of fresh fish are imported from the seacoast towns of Corpus Christi and Galveston, Tex., arriving in Piedras Negras about two days after being packed for shipment at the seaport. Local merchants usually plan their orders for fresh fish in order to take care of Catholic fast days, but it has never been considered a profitable business, owing to the possible loss caused by spoiling while en route and the nonsale of the entire amount.

As the State of Coahuila has no seacoast, the State authorities have made no study of the fishing industry, and the rivers and lakes are not large enough to make fishing a business in this district. Canned fish, such as sardines and salmon, cod and dried herring, are imported monthly, all of which is usually sold to the wholesale merchants by American firms in the United States. After carefully questioning the wholesale houses here I have been unable to find any who purchase fish products from European countries, it being considered, apparently, that the American fish products are closer and of superior quality.

CHIHUAHUA.

[By J. B. Stewart, consul, September 1, 1921.]

There are no fishery products in this district, which comprises the southern two-thirds of the State of Chihuahua. However, the city of Chihuahua is regularly supplied with fresh fish caught in the very large artificial lake known as La Bequilla and situated about 100 miles south of Chihuahua.

Fishery products, consisting of sardines in both cottonseed oil and tomato sauce, salmon, codfish, shrimp, and oysters, are imported into this district almost exclusively from the United States. One large retail grocer is now, as previous to 1914, importing these goods from Spain, but they are so high in price that only a few Spaniards and some wealthy Mexican families can afford to purchase them. These imports are probably not more than 3 per cent of the total imports, about 97 per cent coming from the United States. Since Chihuahua is not a port of entry, import statistics are not available. There is no reexport of imported products practiced in this district.

In the years before the war a very large percentage of all the better grade fishery products came from European countries at reasonable prices, and it is now believed that if it is ever possible to again bring these goods in at prices approaching American prices all except the poor people will again buy the European product in preference to the American because of its past reputation. However, as about 50 per cent of the inhabitants of this district belong to the working class and receive low wages, the big demand is for the cheaper grade of sardines and canned salmon, and dealers do not anticipate that European countries will be able to compete with American manufacturers of this class of goods. Regarding dried cod, it should be mentioned

that this article is only used during Lent, and so the consumption is very small compared with that of sardines and salmon.

Very few complaints have come to the attention of this office regarding the quality of American sardines and salmon. One serious complaint has been received several times regarding sardines which were supposed to be packed in oil but which sometimes arrived with scarcely a drop in the cans. Whether the oil leaks out of the cans or is not placed in them is not known. It is suggested that the matter be given serious attention by manufacturers, as it appears that the sardines soon spoil when there is no oil in the cans.

As nearly the total present amount consumed is imported from the United States, it is only necessary for the American manufacturer to fill orders according to samples and to exercise thoroughness in taking orders, in packing, billing, and shipping of goods in order not only to retain the trade in hand but to increase it as well.

CIUDAD JUAREZ.

[By John W. Dye, consul, August 18, 1921.]

There are no fisheries in the Ciudad Juarez consular district nor any exports or reexports of fishery products. Small quantities of preserved and canned fish, principally salmon and sardines, are imported and consumed in the district. Most of these come from the United States in small lots, largely from El Paso, Tex., just across the international border from this city. There is little prospect of increasing the sale of any fish products in the district, as the population is small and the people poor. A list of El Paso merchants selling fish to Mexico may be obtained from the chamber of commerce, El Paso, Tex.

GUAYMAS.

[By Bartley F. Yost, consul, August 19, 1921.]

In their seasons considerable quantities of fish are shipped fresh, packed in ice, and in a dried salted state. The principal varieties of export fish caught in the Gulf of California near Guaymas are the white bass, black bass, and red snappers. The Spanish mackerel and "bonito" remain unexploited as far as commercial fishing is concerned. Most Mexicans are adverse to eating "scaleless" fish, such as catfish and "pompano." Among the other varieties of fish found in the Gulf in more or less ample quantities are the rock cod, cabrillos, mullet, sardines, "halibut," sharks, sand dabs, chanos (milkfish), porpoise, and sundry small fishes of more or less questionable food value. There are also large oyster beds found at Lobos Island, south of Guaymas. Shrimp are plentiful after October. Turtles are found at all seasons of the year. The catch of spiny lobster is unimportant.

Oysters are taken mostly for local consumption. They are not favorably received in the United States because of the dark fringe. Despite this fact considerable quantities of fresh oysters packed in 1-gallon cans, well iced, were shipped to El Paso, Tex., last winter, sold well and brought good prices. They are of excellent quality. The white oyster, not considered so good here, is most in favor for export and, as a canned product, is said to equal the best oysters from the Atlantic coast. A small packing plant located at Guaymas

last winter put up a quantity of oysters, but on account of the lack of an effective sales organization the venture was not a success.

Shrimps and spiny lobsters are not canned here, neither are they shipped. The white bass, black bass, and red snappers are the only varieties obtained in commercial quantities and at prices capable of competing with the California products in the fresh state.

The method employed by local fishermen in obtaining fish, either for export or local consumption, is with hook and line, baited with sardines and anchovies. During the fishing seasons about 20 canoes, each containing two or three men, may be seen fishing near the entrance to the Bay of Guaymas. The fishermen seldom venture out into the Gulf for any distance. They leave early in the morning and invariably return in the evening about sundown.

A local English fisherman tried fishing with a seine but had to abandon it, as this method requires too many men, most of whom are inefficient and lack organization and teamwork. In seasons when fish are quite plentiful it is believed that this method would be more successful. It is interesting to note, as an indication of the way in which the several varieties of fish are found in a mixed state, that in a haul of 26 fish made this spring on the Morito Beach there were 25 different species. It will be observed that fishing is not carried on here in a systematic or businesslike manner.

As has already been pointed out, there are no fish canned at Guaymas. The only methods of curing fish are those practiced by fishermen on the coast of California. In the case of steak fish, with thick steaks, they are cut open about every half inch and salt rubbed into the incision. They are then laid in the sun, either separately or stacked, and left until the salt has penetrated the fish and all moisture has disappeared. These fish are destined chiefly for local consumption, although an occasional shipment is made to Mexico City during Lent or other festivities. Smaller fish are simply opened, rubbed with salt, and then laid on the ground or hung on lines in the sun to dry. There would appear to be a good opening here for a commercial venture in drying fish and sending them to other parts of the country. It is also believed by a reliable local fish exporter that a market for dried fish could be developed in Cuba and Central America, where they could easily compete with codfish. Black bass is said to make an excellent steak, even superior to codfish, and the cost of the raw product is quite low.

There are no canned fish or dried fish exported from Guaymas. For shipping the fresh fish the California method is employed; that is, 100 pounds of fish to a box, packed in about 25 pounds of ice. The high price of ice is a serious handicap to the industry. It retails at about $1.35 per 100 pounds. These fresh fish are shipped to Hermosillo, Magdalena, and Nogales in Sonora, also to Nogales, Tucson-Phoenix, and a number of mining centers in Arizona, as well as to El Paso, Tex. As a rule the shipments arrive in good condition. Only white bass, black bass, and red snappers are shipped. Although there are no exact statistics available as to the exports of fresh fish, the leading exporter has furnished the consulate with the following approximate figures:

	Tons.		Tons.
October, 1920	8	March, 1921	10
November, 1920	6	April, 1921	8
December, 1920	2	May, 1921	5
January, 1921	2	June, 1921	3
February, 1921	3		

Limited quantities of canned salmon, sardines, and oysters are imported from the United States, but the sales are relatively small. The prices to the consumers are about 100 per cent higher than in the United States. There are a few Spanish mackerel on the market, but practically all the canned sea food used here is imported from the United States. There is no reexport of imported products, due to the unfavorable location of this port as a distributing center for more than a local territory.

The only canned product arriving here from countries other than the United States is an occasional shipment of Spanish sardines packed in oil. If the European product could compete with the American packed goods in the matter of price, it is believed that the former would be preferred by the natives, owing to the traditional taste of the Latin race for highly spiced food. Since the outbreak of the World War the unfavorable transportation facilities have precluded the possibility of bringing European goods to any extent to this part of Mexico. However, with the establishment of steamship service between European ports and the west coast of Mexico, which will soon be accomplished, the market here for many articles is certain to be lost to the American exporter.

There is little likelihood of there ever being a considerable market in this consular district for American packed sea food of any kind, inasmuch as most of the district can be served with fresh fish from Guaymas. Advertising campaigns and artificial stimulants could help but little to develop the market. Fresh fish is abundant most of the year, and the canned products from abroad are almost prohibitive in price except to people of means. The masses can not afford canned sea food. . If the mines are ever reopened, there will be a limited market for canned goods among the mining population, where fresh fish and fresh fruit can not be delivered.

MEXICALI.

[By Walter F. Boyle, consul, August 17, 1921.]

There are no local fishery products in this district. At one time a group of Americans tried to exploit the fishing grounds at the head of the Gulf of California, reputedly very prolific. They employed a power boat from the headwaters of the gulf to La Bomba on the Colorado River, and thence shipped by motor truck to Mexicali, nearly a hundred miles, over very indifferent roads. The transportation charges proved too onerous, and the enterprise was abandoned. Several attempts have been made to exploit the fish in the Laguna Salada, some 20 miles from Mexicali, solely for the purpose of obtaining fertilizers, but this too has been abandoned. This shallow lake at times goes dry because of evaporation in a rainless valley. All commercial fishing has been with nets used as seines. The effort to bring fish from the Gulf of Colorado was directed to packing in ice, while the fish caught for fertilizer in the Laguna Salada

were allowed to decompose on the beach. The Diario Oficial, the official publication of the Mexican Government, from time to time contains fishery concessions to exploit the waters around Lower California. Some 12 tons of fertilizer cover the only fish products exported since the opening of this office on January 1, 1919.

There are no available statistics relative to fish products imported, though it is safe to say that practically all imports of this nature came from the United States, it being customary for the consumers to buy most of their provisions at retail on the American side of the border, exporting them for use on their plantations, or if in small quantities for direct personal use, bringing them across in person, thus avoiding the payment of customs duties, small parcels of food being freely passed without the assessment of duty when carried by the purchaser. There is no reexport of imported products.

The only fish products imported from foreign countries other than the United States are several varieties of dried fish from China, imported exclusively by and for the consumption of the large Chinese population in Mexicali. The United States has the trade, and as long as this district remains without transportation to foreign countries other than through the United States and continues to do its retail trade on the American side of the border, two conditions which seem likely to continue, there is but little chance of losing the trade. Advertising might help to increase the demand, but there is no foreign competition to be met.

ENSENADA.

[By William C. Burdett, consul, August 29, November 4 and 5, 1921.]

The fisheries of Lower California constitute its most important industry. Aside from a small amount consumed locally all of the fish is exported to the United States, and due to the abundance of locally caught sea food there is no importation of fish into the Territory. The principal fish are barracuda and "halibut," the several varieties of tuna coming next, with sea bass, yellow tail, bonito, rock cod, and mackerel each furnishing its quota. Minor catches are made of perch, sea trout, shark, whitefish, and smelt.

Several fish canneries were established in Lower California but did not prove profitable, and at this time none are in operation. The tuna, comprising about 8 per cent of the total catch, and the skipjack, 2 per cent, are canned at San Diego, Calif. The remainder of the fish is sold fresh to the fish companies at San Diego and San Pedro, from which cities they are sent throughout California and the southwestern States.

The sea food exported from Lower California to the United States in 1920 totaled 8,129,173 pounds. Of this amount there were 6,981,503 pounds of fish, 942,020 pounds of crustaceans, chiefly spiny lobsters, and 197,585 pounds of mollusks, chiefly abalones. No fish fertilizer is exported from Lower California, but a small amount of shark oil finds its way to the United States, as well as a few hundred pounds annually of shark fins, this last destined for consumption by Chinese.

The following table, compiled by the California Fish and Game Commission, shows the number of pounds of fish received at San Diego and San Pedro, Calif., from Lower California during 1920:

Species.[1]	San Diego.	San Pedro.	Total.	Species.[1]	San Diego.	San Pedro.	Total.
Abalone	63,651	31,459	95,110	Sea trout	5,562	....	5,562
Barracuda	1,055,444	2,560,503	3,615,947	Shark	....	12,628	12,628
Bass, sea	234,763	70,305	305,068	Skipjack	4,245	10,844	15,089
Bonito	36,079	165,176	201,255	Smelt	9,877	3,835	13,712
Clams	20,730	4,827	25,557	Stingaree	....	24,885	24,885
Halibut (bastard)	1,631,531	46,008	1,677,539	Tuna	226,318	10,844	237,162
Lobsters, spiny	941,590	430	942,020	Tuna, yellowfin	....	487,119	487,119
Mackerel	33,426	17,306	50,732	Turtle	76,983	....	76,983
Perch, surf	4,355	885	5,240	Whitefish	3,377	1,475	4,852
Rock cod (rockfish)	97,116	545	97,661	Yellowtail	76,750	141,650	218,400
				Miscellaneous	12,043	1,424	13,467
Sardines (pilchards)	....	3,185	3,185	Total	4,533,840	3,595,333	8,129,173

[1] Fish caught outside the 3-mile limit are free from Mexican taxes and are not included in the table.

All fishing is done from power schooners ranging from 3 to 40 tons net and sailing out of San Diego and San Pedro, Calif. The larger boats are operated by Austrians and Serbs and carry purse seines. There are some 55 such boats in San Pedro, of which number 42 fished in Lower California waters during October, 1921. Purse seines average 250 fathoms in length and 20 fathoms in depth, with a mesh of only 2½ inches. When the catch is made, the fish are iced and taken to market at San Pedro.

Effective November 1, 1921, an important decree affecting fishing activities in Mexican waters has been issued. According to the new law the use of purse seines is prohibited in the waters of Lower California. Various influences have urged upon the Mexican Government the importance of prohibiting purse seining here. The new law will result in somewhat limiting the supply of fish in Southern California ports, with a possible increase in price, but this condition will be temporary, as the same boats will provide themselves with other types of nets of smaller size and larger mesh, so that eventually the same amount of fish will be taken to port. The new law provides for a heavy fine and confiscation of the boat for violation, and a Mexican coast patrol vessel has been ordered to seize all offenders after November 1. Americans, Italians, Portuguese, and Japanese operate smaller boats and fish with gill nets, hand lines, and jigs. Tuna are caught exclusively with hand lines.

The Mexican Government collects a fishing tax of $1 per month per gross ton from boats fishing within the 3-mile limit, and in addition a tax of $18.50 per ton of fish caught, maintaining inspectors on the docks at San Diego and San Pedro to weigh the fish as they are brought in.

The chief export from this consular district is abalone. This mollusk abounds all along the Pacific coast of Lower California and is found attached to rocks from low-tide line to a depth of 30 or more feet. The industry is handled by Mexicans and Japanese having their offices and distributing centers in San Diego, Calif. There are three varieties of abalones—red, yellow, and black. The red is rarest and best, the yellow more common and not so much esteemed, while the black is the most abundant and least liked. Abalone may be fished for in Mexico throughout the year, and there is no size limit. Divers working with regulation diving suits and going down to a maximum depth of 30 feet pry the abalones off the rocks with pinch bars. A good diver will collect 2 tons of abalone in a 4-hour day, weight figured on shell and meat together.

The abalones are usually cured and canned before export. The process consists of removing the mollusk from the shell, boiling it three times and changing the water with each boiling, then drying it in the sun. When thoroughly sun baked, they are packed in 1-pound tins, averaging three abalones to the tin. After reaching the United States most of the abalone, both dry and canned, is reexported to Hawaii or Japan. Its consumption is almost entirely confined to Japanese and Chinese. The shell is exported to the United States, where it is used for carving curios and shell buttons and is also ground for poultry food.

The spiny-lobster fishery is becoming one of the most important industries of the Pacific coast of Lower California. While this crustacean is marketed in the United States as lobster, it is quite distinct from the lobster of the eastern seaboard. The spiny lobsters are found along the coast from the American border to Cape San Lucas. The best fishing grounds, however, are between Point Eugene and San Ignacio Lagoon. Camps are established along the coast, and the fishermen work out in rowboats, placing their lobster pots at intervals along the rocky islands and coves. These pots are made with a small aperture into which the lobster crawls, attracted by a bait of meat or abalone. Sharp prongs prevent its egress.

The lobsters are then collected at the camps and carried by fast power boats to San Diego, Calif. A converted submarine chaser is being tried out as a lobster carrier, speed being essential in order to get the crustaceans to San Diego while still alive. The carrier boat must submerge the lobsters once every 18 hours on the trip to San Diego, this being accomplished by lowering the crates over the side. Thirty-four power vessels from the United States are now engaged in the industry. On arrival at San Diego the lobsters are at once boiled. A few are kept alive and thus sold to restaurants, but most of them are marketed already cooked. They are placed in boiling water while still alive, and after boiling for 20 minutes are cooled and placed in cold storage. From San Diego they are distributed throughout the southwest. Only such spiny lobsters as are between 10½ and 16 inches in length may be taken into the United States, and imports of undersize or oversize lobsters are subject to fine.

At this time fishermen are paid 9 cents a pound for the lobsters laid down at the camps. There is a certain loss in shipment and a shrinkage in weight of 15 per cent when boiled. At this time the cooked lobsters sell at San Diego for 26 cents a pound wholesale. The Mexican Government, besides several minor duties, dues, and charges, places a flat export tax on lobsters of 2 cents, American currency, a pound.

La Paz is the center of the pearl-fishing industry. Although the Gulf of California is a very prolific fishing ground, very little market fishing is done, as there are no gulf ports readily accessible to the United States.

MAZATLAN.

[By E. Schroder, vice consul, September 2, 1921.]

The principal local fishery products in this consular district are fish, oysters, shrimp, and shark fins, but at the present time no commercial fishing for export purposes is carried on. The few

dried fish, shrimp, and shark fins that are being exported at the present time are purchased from local fishermen at different points in this district in small quantities by various houses, principally Chinese concerns.

Straight nets and cast nets are used for catching fish in shallow water. The cast net is also occasionally used for shrimp, but the majority of shrimp are caught in an oblong trap called a cacaiste. This is similar in appearance to the oblong wire traps used for catching rats and is made of sticks and twigs, braided and interlaced. It is baited with decayed meat, bones, fish, and similar matter, weighted with stones, and dropped into the water from the side of the canoe. Fishing for both fish and shrimp is always done at night and only in inland waters. Sea fishing on a commercial scale is not followed at the present time, as no one in this district has the necessary apparatus. Oysters are obtained by diving, very few being secured in any other manner.

Fish and shrimp are cured both by Chinese and native methods. In curing fish by the Chinese method they are packed in large boxes, thoroughly salted, and allowed to remain packed for from four to eight days, according to the size of the fish. They are then taken out, thoroughly washed and scrubbed with a small brush, and put out in the sun to dry. Fish cured by local methods are split open from the back to the belly. The side to which the backbone is attached is again split and the backbone removed. They are then scored with a very sharp knife, on both sides in squares ½ inch to 1 inch wide, then thoroughly salted, and placed in the sun to dry.

Shrimp cured after the Chinese method are cooked from 15 to 20 minutes with a very little salt in the cooking water. After being taken out of the cooking kettle they are placed in a sack and beaten against a wall or board. By using very little salt in the cooking the shell separates from the body without difficulty in the process of beating. As the select trade demands a perfectly clean shrimp, with no particles of shell adhering to the meat, after this beating process the shrimp are placed in a conical basket of special construction. This is about 2½ feet high, 2 feet across the top, and from 12 to 14 inches across the bottom. It is filled to about one-third its capacity, and the contents are churned with a three or four pronged stick, which removes any particles of shell or legs still remaining. Curing by local methods, shrimp are cooked for the same length of time but with a great deal of salt. Upon being removed from the cooking kettle the shell or skin is shriveled and hard and can only be removed by picking it off with the hands. This is caused by using so much salt in the cooking in contrast with the Chinese method.

Oysters are cured almost wholly for local consumption, only one small shipment having been exported to the United States from this district in the last two years. They are opened by toasting over a light fire, removed from the shell, placed in a large tin container, thoroughly salted, and shipped to the local markets. They will keep indefinitely by this method, but the oyster gets very tough and unpalatable. According to consular invoices certified to at this consulate the quantities and values of fishery products exported to the United States from this district for the fiscal year ending December 31, 1920, and from January 1 to August 31, 1921, were as follows:

Product.	Fiscal year ending Dec. 31, 1920.		Jan. 1 to Aug. 31, 1921.	
	Pounds.	Value.	Pounds.	Value.
Fish, dried and salted	107,097	$10,560	127,953	$8,853
Shark fins	507	362	608	781
Shrimp, dried	84,825	20,630	21,142	4,401
Fish stomachs			211	32
Oysters, dried			37	7
Total	192,429	31,552	149,951	14,074

The only importations of fishery products into this consular district are canned salmon, sardines, and a very little tuna, crab, and lobster. According to the best information obtainable none of these imported products is reexported. The only fishery product imported from countries other than the United States is sardines. While no figures are available as to the quantities and values of the sardines imported, it has been estimated that the quantity would not amount to over 50 per cent of the amount imported from the United States. The majority thus imported usually come from Spain. To increase the imports of all fishery products packed in cans or in jars into this consular district, the excessive import duties placed on these products would have to be considerably reduced. Packers in the United States should make an effort to ship a superior quality of goods.

AGUASCALIENTES.

[By H. G. Bretherton, vice consul, September 3, 1921.]

There are no local fishery products in this district. Fishery products are imported to the amount of approximately $15,000, United States currency, annually, and consist principally of sardines, canned salmon, and dried cod. About 60 per cent of all fishery products imported into the district comes from the United States, due principally to the proximity of the two countries. At present the American sardine dominates the market, but the Spanish is following close, and if Spain continues to lower sardine prices and the transportation facilities improve no doubt the Spanish article will lead, because it is put up in olive oil, while most of the American sardines received here are packed in cotton-seed oil. The American-dried cod dominates the market, due to the proximity of the two countries, but the Norwegian-dried cod is preferred. Other than reasons stated, the lowering of prices, which all the other countries are practicing at present, will do more than anything else to increase importation from the United States.

GUADALAJARA.

[By A. J. McConnico, consul, August 26, 1921.]

There are no fisheries in the Guadalajara consular district. According to conservative estimates the value of fish products imported into this district annually is $66,000. The United States supplies fully 90 per cent of this, the remainder being supplied by Spain and Norway. The market for salted, smoked, and pickled fish is limited, the annual consumption not exceeding 3,000 pounds. Norway contributes about 2,000 pounds and the United States the remainder.

This is imported in tins containing 5 or 10 packages and is retailed in 1-pound or in 1-kilo packages, at the rate of 55 cents, United States currency, per pound. Dried fish from Vera Cruz and Manzanillo is also consumed to a small amount by certain classes.

United States exporters control the market for salmon. About 5,000 cases, valued at $25,000, are imported annually from the United States. Most of the imported varieties are known as "pink" and "chum," there being little demand for the "red."

It is estimated that 7,000 cases of sardines, valued at $40,000, are imported annually. Spain supplies 1,000 cases of the better grade sardines preserved in olive oil, and the United States 6,000 cases of sardines preserved in tomato and cotton-seed oil. All of these are packed in ¼-pound tins, with the exception of the variety known as "California," the weight of which is 15 ounces. Spain commands the market for the better grades preserved in olive oil, because the prices are nearly 50 per cent less than American sardines preserved in olive oil. The United States commands the market for the cheaper grades preserved in tomato or cotton-seed oil, six cases of American sardines being sold to one case of Spanish. There appears to be a decided preference for the Spanish sardine by the more exacting, and this preference can not be overcome till the American exporter offers sardines of a better grade preserved in olive oil at prices as reasonable as those of the Spanish product.

MANZANILLO.

[By Stephen E. Aguirre, vice consul, October 14, 1921.]

The fishermen of this district do not go to sea to fish, as is customary in other parts of the world, except during the holy weeks. Because of the large demand in this district for fish and the decidedly high prices paid there should exist a very good opportunity on this coast for the development of a first-class fishery. There are no fishery products other than for local consumption. Such fish as is consumed locally or shipped in small quantities to Colima or Guadalajara during holy week is caught by a few natives who use fishing lines in the absence of suitable nets. No methods of curing fish for market are employed, since nothing but fresh fish are shipped. Only small quantities of fresh fish are exported from the district and those only to interior Mexican cities.

Canned salmon and sardines imported through this port to cities in the interior of Mexico come from the United States. Recently a shipment of 2,250 cases of canned salmon, valued at $6,579 United States currency, was brought to this port. Imported fish products are not reexported. Fish products imported to this port from the United States predominate over foreign goods because of the short distance to American markets as compared with Spain, Italy, or France. Until a fishery is established at this port or on the west coast of Mexico American fish products will find a ready market, and the present volume of business can be increased by the establishment on the Mexican west coast of a central distributing point for American products, the location of which should be carefully selected. Merchants in Mexico who purchase large quantities of American canned fish would no doubt increase such purchases if able to obtain these goods at a Mexican port.

MEXICO CITY.

[By Cornelius Ferris, jr., consul in charge, August 24, 1921.]

There are no fisheries in the consular district of Mexico City. Fishery products are imported only from the United States.

VERA CRUZ.

[By Willys A. Myers, vice consul, September 28, 1921.]

The warm waters of the Gulf teem with fine fish, turtles, crabs, oysters, and shrimp. Chief among the prized fishes is the Huachinango (*Lutianus blackfordi*), a red snapper, very abundant off the coast. The red snapper is a deep-water fish, being taken on the fishing banks outside the 3-mile limit, and is fished for by the Mexican fishing fleets, thus insuring fresh fish in the Vera Cruz market at all times. Numerous American fishing schooners in the past years have been sent here by the Galveston and Tampa fishing companies of the United States. At certain times of the year there are heavy runs of small mackerel suitable for canning, which are sold very cheaply. In the spring and fall there are runs of a species of sardines of small size and of a very delicate flavor. At present the only use made of these two runs is domestic.

Shrimp and fish are sundried. There are no large drying plants, the work usually being done by the local fishermen. The quality of the fish is of a very low grade and is consumed only by the poorer classes in Mexico.

Vera Cruz is the distributing point for the east coast of Mexico and all interior points. The only fishery product exported from this port is the octopus or cuttlefish, known here as the "pulpo." During the year 1920, 21,645 pounds of octopus, valued at $3,842, were exported.

Codfish, salmon, and sardines are imported in large quantities, statistics regarding the values and amounts of the above-mentioned products not being obtainable. Whole dried codfish is the best seller and is imported principally from Norway, although a certain amount is received from the United States. American salmon, Alaska pink, in 1-pound tall cans, is demanded by the buying public in Mexico. Until within the past two years the greater part of the sardines sold in Mexico came from Spain. At the present time American sardines, packed in oval cans with tomato sauce, net weight 15 ounces, are the largest sellers and sell at a cheaper price than the Spanish product.

As Mexico is a Catholic country, there are numerous feast days in the year on which fish of some kind is always served. As fresh fish is always available here, there is a much larger quantity sold in the interior than in this immediate territory. Labels for salmon cans should have the word "Pink" in large letters, as the buying public always look for the word "Pink" when making purchases. The higher grades of salmon do not sell here, and there is little demand for "Chum," Alaska pink being the best seller.

Sardines packed in pure olive oil, oval cans, weighing 15 ounces net, should have a good sale here. The objection to the American sardine in oil is that cottonseed or a substitute for pure olive oil is used. Spanish sardines are all packed in pure olive oil in small cans. There is a growing demand here for the larger sized containers. Newspaper advertising and window displays would increase the sale of these

products, as the Mexican people are beginning to call for and demand the advertised goods. Prompt shipment of orders, c. i. f., careful packing to insure delivery in good condition, prompt forwarding of all documents of shipments, notification to purchaser as to bank at destination through whom papers have been sent, would help to increase the importation of these products. There are no pure-food laws or inspections of these products in Mexico. The Mexican import duty on codfish is 10 centavos per kilo, or 5 cents American money, to 2.2 pounds; on salmon and sardines, 20 centavos, or 10 cents American money.

ACAPULCO.

[By Harry K. Pangburn, vice consul, November 24, 1921.]

The principal local fishery products in this district are fresh sea fish, lobsters, clams, and oysters, which are sold locally. Fishing is usually done at night from canoes with lines and nets. There are no power boats or sailboats regularly employed in fishing, although trolling from power boats is resorted to occasionally. Practically all the fish are sold at once, while fresh, in the local market place. Sometimes certain species of fish are cleaned, salted, and dried in the tropical sun. No fishery products are exported. There has been a limited market here for imported fishery products, such as canned sardines, canned salmon, and dried codfish. While the exact figures of importation are not obtainable, careful inquiry from the importing houses of this district developed the fact that the total importation of fishery products in the district does not exceed $1,000 per year in value. For some years past all importations have come from the United States and have been shipped almost entirely from San Francisco. There is no reexport of imported fishery products.

The abundance of fresh sea products easily obtainable at a low price makes difficult the sale of the imported fishery products which have to pay duty and consequently have to be sold at a higher price. The importers see no chance for a more extensive sale of imported fishery products until the present business depression passes and the people are enabled to purchase these food products which are now considered as luxuries. The purchasing public of this district has never acquired a taste for the sea foods mentioned above, and if a market should be sought here it might be well to send for free distribution some small samples of the products in order that a demand may be created for them.

SALINA CRUZ.

[By Lloyd Burlingham, consul, September 6, 1921.]

A limited amount of fresh fish is taken from the sea and sold fresh for consumption. There are no other fishery products. Fish are taken in nets either in the outer harbor or else with rowboats about 1 mile from shore in good weather. Fish are not cured. No fishery products are exported.

About 500 cases of pink salmon are imported each month from the United States. Perhaps 10 to 25 cases of tinned sardines are imported per month into this consular district, about half coming from the United States and half from Europe. There are no other imports of importance. There are no reexports of imported products. Sardines are the only fish imported from Europe. The price is probably the governing factor.

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FRONTERA.

[By Harry W. Pascoe, vice consul, September 20, 1921.]

The many rivers of this section furnish an abundance of fish which supplies the local markets, but none is exported. Shrimp in large quantities are found off the coast, but these are used entirely for local consumption.

The fish imported consist almost entirely of canned products, such as sardines of all kinds, salmon, oysters, lobster, and anchovies. Some dried cod is also imported. The imports come chiefly from the United States and Spain; some come from Norway and Sweden. Dried cod sells for about 25 to 30 cents, United States currency, per pound; canned salmon, for about 20 cents per can; sardines, for from 20 to 30 cents per can; oysters, for about 20 cents per can; and lobster, for about 65 cents per can.

Between the Mexican ports of Puerto Mexico and Frontera lie three river bars, Santa Ana, Dos Bocas, and Chiltepec, across whose sands pour immense quantities of water. In each case rather large lagunas (lakes) are found at the mouths of these rivers, in which several varieties of fish abound, as well as oysters and shrimp. The native oyster is much larger than the Louisiana cove oyster and has an excellent flavor. It may be found in sufficient quantities to warrant exploitation for the establishment of canneries. The robalo, "shad," sardine, and several native fish known locally as huachinango, lisa, pargo mulato, and cazon, abound in these lagunas also in such quantities as to merit the attention of canning firms seeking an extension of their business. Due to the tropical climate the oysters and fish must be handled rapidly whether intended for canning or for refrigeration. The season for most of these varieties is from April to September. The "shad" is the most numerous. These lay eggs in masses weighing from 3 to 7 pounds which may be made to rival caviar. Several kinds of turtles are also found. The water on these bars varies in depth from 5 to 9 feet deep, and only small schooners call there. A voyage of 12 hours is required to reach either Frontera or Puerto Mexico, the nearest customs ports.

PROGRESO.

[By O. Gaylord Marsh, consul, August 26, 1921.]

The principal local fishery product in Yucatan and Campeche, Mexico, is fresh fish, mainly yellow jack, pompano, red gurnard, Spanish mackerel, red snapper, jewfish, red grouper, moharra, robalo, stingray, dogfish, weakfish, mullet, and grunts. Of the foregoing dogfish, red grouper, red snapper, and pompano have the largest sale. Fishing for this market is carried on off the port of Progreso, on the Campeche banks, and at the Alacran Reef. The smaller settlements do fishing at various points on the coast.

The largest number of fish are caught on hook and line, some are speared, and some, principally pompano and mullet, are caught in nets. The fish are kept in wells in the smacks and brought to the market fresh as needed. Some fish, principally dogfish and pompano, are preserved by smoking, salting, or cooking. There are no exportations of fish. Lobsters, octopus, squid, white turtle, turtle eggs, and mullet roe are also offered for sale in the market by the fishermen.

Considerable quantities of American canned salmon are imported. Canned and dried codfish of American origin is offered for sale by

the leading grocers. American and Spanish sardines are imported in important quantities, the choice of the one or the other being based on personal taste or business reasons of the moment. A few other American and European, principally Spanish, preserved fish products are available in unimportant quantities. None of the important products are reexported. No statistics or estimates are available at the local customs and internal revenue offices as to importations.

The importations of foreign preserved fish products are now on the decrease and will be very small until the henequen industry has a favorable reaction, which may not occur for a couple of years. The only present means of advertising American fish products and stimulating their use is by means of correspondence with importers and by soliciting the patronage of American export commission houses.

LIST OF THE FISHES OF YUCATAN.

Native name.	English name.
Cojinuda	Skipjack.
Jurel, small	Yellow jack or yellow mackerel.
Jurel, large	Cavally.
Pompano	Pompano.
Bagre	Catfish.
Rubia	Red gurnard.
Bonito	Tuna.
Pulpo	Octopus.
Sierra, small, spotted	Spanish mackerel.
Sierra, large, not spotted	Kingfish.
Picuda	Barracuda.
Huachinango	Red snapper.
Cherna	Jewfish or gausa.
Pargo	Gulf scup.
Mero	Red grouper.
Savalo	Tarpon.
Mojarra	Moharra.
Zapatero	
Robalo	Robalo.
Bufeo	Porpoise.
Raya	Stingray.
Cazon	Dogfish.
Corvina	Weakfish.
Lisa	Mullet.
Sapo	Toadfish.
Dorado	Squirrel fish.
Salmon	
———	Angel fish.
———	Doctor fish.
———	Oldwife.
———	Bonefish.
———	Bonyfish.
Macavi	
Esmedregal	
Angel	
Cochinita	
———	Hogfish.
Sardina	Sardine or sprat.
Toro de Mar	Cowfish.
———	Hind.
Chacchi	Grunt (blue striped and others).
Pejerey	
Bulcayito	
Pega pega	Shark sucker.
Roncador	
———	Sailor's choice (species of grunt).
Isabelita	
Espada	Swordfish.
Jorobado	

CENTRAL AMERICA.

GUATEMALA.

GUATEMALA CITY.

[By Arthur C. Frost, consul, October 19, 1921.]

The fishing industry in Guatemala is of purely local concern and very limited in scope. Fish are caught both on the Atlantic and Pacific coasts and are sold for the most part in the near-by markets. Shipments into the interior are of neligible importance.

Red snapper, Spanish mackerel, shrimp, and crayfish are caught in Guatemalan waters, the total catch in the principal ports amounting to no more than a few hundred pounds a day. Hook and line and hand-drawn seines are employed in obtaining fish in Guatemala. The catch is eaten fresh, except for a small amount of shrimp which is sun dried. No fish are exported or reexported from this country.

A limited amount of salted, pickled, and smoked fish is imported into Guatemala, but the market is necessarily small. An abundance of fresh fish is to be had on either coast, and Guatemala City, which is the chief commercial center and consuming point of the Republic can obtain fresh fish from the Pacific port of San Jose, a distance of 75 miles.

The people of Guatemala eat very little preserved fish, and fresh fish is rarely an article of diet for people living in the interior. Preserved fish is eaten by the Guatemalans, as a rule, during Easter week only. The consumption during this week probably exceeds the entire quantity used during the rest of the year. Fish products are imported principally in the first calendar months to provide especially for the Easter season.

The total white population, native and foreign, of this Republic is only about 60,000, and this class constitutes the sole users of imported fish products. The foreign population eat preserved fish of various kinds throughout the year, but the consumption is of slight commercial importance. Retail prices of canned fish are two, three, or even four times as much as those prevailing in the United States because of ocean freight, inland transportation, and heavy duties.

The principal fish imported include canned salmon, sardines, anchovy, oysters, kippered herring, caviar, cod, and other salted fish. The United States, France, England, Sweden, and Norway are the chief sources of supply. Codfish sold in the capital comes from San Francisco, New England apparently having no share in this trade. It is sold in cardboard packages of 1 or 2 pounds, and also in 1 or 2 pound bricks which come packed in wooden boxes, 40 pounds net and 50 pounds gross. Pickled fish is imported from Alaska to a very slight extent. It comes in barrels, containing 400 or 500 fish, net weight 600 pounds, gross weight 700 pounds. Kippered herring and sardines are the principal smoked fish imported and are sold in cans of 1¼ pounds, 1 pound, and smaller sizes. Smoked herring is imported from Alaska, Norway, and England. Sardines, lobster, caviar, and other specialties are imported to a limited extent from the United States and Europe, principally for use by the foreign colonies. In the case of certain products, such as sardines, there is a preference for European varieties on account of taste or supposed superior quality.

The imports of dried, salted and smoked fish for the years 1913, 1919, and 1920, according to Guatemalan customs statistics, are stated below. This table does not convey a correct idea of the market however, because, on one hand, European goods enter via the United States, and, on the other, certain kinds of preserved fish are not included in this table but figure in the general custom statistics among unclassified preserved products.

	1913		1919		1920	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
United States	236,221	$14,801	65,659	$12,316	125,893	$22,235
Sweden					400	55

As the market in Guatemala for fish products is so limited, it is not considered of sufficient interest to the American exporter to justify an advertising campaign or the sending of a representative to solict business except as a side line. Fish products are sold by the grocers in Guatemala, who purchase directly from abroad, and the best means of selling these products is to place them in the hands of one of the principal dealers.

HONDURAS.

PUERTO CORTEZ.

[By Albert H. Gerberich, vice consul, August 31, 1921.]

There are small deep-sea fisheries in the vicinity of Puerto Cortez, and for this reason fresh fish are always available at the port and coast towns. In San Pedro Sula and the interior of the district, however, fresh fish is a rarity. The following tropical fish are those usually sold hereabouts: Jackfish, barracuda, grouper, red and black snapper, etc. Many lobsters and crayfish from the keys of British Honduras find a ready sale. Fish marketed in this consular district are usually taken with a seine. The fish mentioned and the following additional varieties are salted and cured on the keys of British Honduras and are sold in the local market: Spanish mackerel, kingfish, rockfish, and others. The fish are cured by cleaning, salting, and drying in the sun. No fishery products are exported.

The following fishery products are imported: Canned salmon, sardines, salted herring, codfish, and mackerel, pickled mackerel, smoked herring, and codfish bricks. The salted fish come in cases of 20, 40, and 100 pounds; the pickled fish, in 50-pound tubs; the smoked fish, in 20-pound wooden boxes; the codfish, in bricks in 40-pound boxes. With the exception of the smoked fish the market is comparatively small. Canned salmon and sardines sell very well throughout the district. All imported fish come from the United States, with the exception of a very small quantity of mackerel from Spain. There is no reexport of imported fish products.

American fish products practically monopolize the Honduras market, and it is believed by the officer who submits this report that all methods of increasing the market for such products from the United States have been exhausted. While there is a good market at the present time in proportion to the number of inhabitants,

the largest consumers are the foreign families and the native families which from long residence along the coast have acquired a taste for American canned goods.

No figures are available at this consulate for fish imported from the United States during the last fiscal year, with the exception of salt and pickled fish. Of these 80,194 pounds were imported, representing a total value of $21,617.51. It is probable that figures representing the total value of fish imported into Honduras can be secured from the consulate at Tegucigalpa.

TELA.

[By S. L. Wilkinson, vice consul, September 25, 1921.]

Other than a very negligible quantity of small fresh fish taken by primitive methods and sold each morning on the beach in open market there are no fishery products in this district. The fish are caught in small throw nets or with hook and line, usually from small canoes or the wharf. Dried fish is the principal diet of the "Caribs" (Jamaican negroes), who live in small villages along the coast. The fish are cleaned, salted for a short period, and placed in the sun to dry. No scientific method of preparation is employed.

The fishery products imported consist of sardines, shrimp, crab meat, salmon, etc., in tins or cans. None of the imported products are reexported. While no statistics are available at this port, this office has made a thorough investigation and taken note of the stocks of canned fishery products of practically all the merchants handling this class of goods, and of the seven stores visited only two had supplies of canned fishery products originating in countries other than the United States. These consisted of small stocks of sardines and "calamares" (squids) imported from France and Spain. In the cases cited the preference for foreign goods is no doubt due to the fact that the merchants are Spaniards and have long-established connections with Spanish exporting firms. Customs importation statistics by ports of entry and for the Republic may only be obtained from the "Oficina Estadistica" in Tegucigalpa. Over 95 per cent of the total fishery products imported into this district originate in the United States. This is believed to be a very conservative estmate.

LA CEIBA.

[By Alexander K. Sloan, consul, November 30, 1921.]

Although the sea in the vicinity of La Ceiba abounds in food fish such as tarpon, mackerel, and red snapper, there is not enough sea food brought into this port to supply the local market. The reason for this condition seems to be the fact there is a tax upon fishermen which costs them $6 every time they lift their nets. As a consequence there are no fish cured, preserved, or canned for either local consumption or export.

While there are no statistics available which show the value of the imported fish products, it has been estimated by the principal merchants and commission men of La Ceiba that the total amount imported averages about $4,000 per annum. Lobsters, oysters, clams, and shrimp are imported almost exclusively from the United States, sardines from Spain, Norway, and France, although a small

percentage of these come also from the United States. None of this class of goods is reexported.

As stated before, the only fish products imported from countries other than the United States are sardines. The merchants of La Ceiba claim that the Spanish sardine is not only cheaper than the sardine imported from the United States, but is packed in olive oil, not cottonseed oil, which material they claim is used in the packing of sardines from the States; that sardines packed in oil, the only kind equal to the Spanish sardine, are so expensive that their importation is rendered prohibitive. They also claim that the sardine from Norway is as good as that from the United States and much cheaper, and that the French sardine is put up in much better shape and costs no more.

If exporters can convince the merchants here that the American sardine compares favorably with sardines from other markets or, failing that, can offer prices which will be slightly under that of the other sardines, it will be an easy matter to drive European competition from this market. This is true for two reasons: First, the element of time is greatly in favor of American exporters, and, second, fully 95 per cent of all the goods used in this vicinity is from the United States, the people being accustomed to the American trade-marks and liking American goods.

SALVADOR.

SAN SALVADOR.

[By Lynn W. Franklin, vice consul, September 30, 1921.]

There are no local fishery products in El Salvador. A small amount of fishery products is imported, but there do not exist any available or reliable statistics showing their kinds and value or country of origin. According to reliable official information none of these imported products are reexported. During the war, fishery products were not imported to any extent from foreign countries other than the United States. From personal inquiries it appears that approximately $100,000 worth of these products is imported annually, of which 25 per cent comes from the United States in normal times.

There is a tariff for certain products from France, Germany, Italy, Belgium, and such other nations having treaties with El Salvador containing the favored-nation clause, and fishery products from the United States pay approximately 25 per cent more than those from such favored nations. American products, such as sardines, canned salmon, dried cod, etc., which are also produced in foreign countries and imported therefrom into El Salvador, have to compete with similar products enjoying reduced import duty, as well as to overcome the general impression among the buyers that the Europeans sell a better quality of article, except canned salmon and dried cod.

NICARAGUA.

BLUEFIELDS.

[By Thos. W. Waters, vice consul, September 21, 1921.]

The principal local fishery products in this district for export are hawksbill and green turtles. Fishing for other species is carried on by

local fishermen for the local fresh-fish market only. The method employed in fishing for turtle is by nets, which are set where the turtles run, while the harpoon is employed occasionally. Fresh fish are caught on a very small scale in nets made locally by the natives, who go out in small dories, mostly singly. There is no curing of fish for market.

Hawksbill and green turtles are exported from the cays along this coast, finding a market generally in Tampa, Fla., being conveyed in small fishing schooners that ply in this trade. The total value of turtles exported during the year ending December, 1920, was $27,530. The price paid locally for green turtles ranges from $10 for females to $14.50 for males, full grown. Hawksbill turtles are often sent out alive, and the meat is then used as well as the shell, but the value is based entirely on the size and is arbitrary.

The fishery products imported are salmon in tins, all from the United States, price in New Orleans, La., from $1 to $3.25 a dozen; codfish and hake put up in 40 to 100 pound boxes, from the United States, at 9 cents a pound; sardines in tins, the cheaper grades from the United States and the better from France, Norway, and Spain, American from $4 to $9 a case, French about $16 a case, and Norwegian about $22 a case; fish flakes and tuna fish all in tins, 6½ to 7 ounces, mostly from the United States, fish flakes $1.40 a dozen, and tuna fish $2.10 a dozen.

All fishery products imported are for local consumption only. Sardines are imported from France, Norway, and Spain, as the local opinion is to the effect that these countries produce a finer grade and that they are better put up in olive oil or tomatoes. The other products, such as codfish, canned salmon, etc., all come from the United States and are very popular. It is probable that, in the case of sardines, an educational campaign by the manufacturers would be advisable. The fresh-fish trade is taken care of locally, and there is not much opportunity for expansion. There should be a much larger trade in codfish and hake, which are very popular food products in this district.

CORINTO.

By Henry S. Waterman, consul, September 21, 1921.]

The fishery products taken in this district are for local consumption only. They are salted and dried, the business being conducted in a very primitive manner and flourishing principally during and just before Lent. At that season of the year coast natives fish for whatever they can catch, clean the fish, salt them, and hang them over poles to be sundried. The fish usually caught on the Pacific coast of Nicaragua, in the order of their abundance, are the yellowtail (ureles), rooster fish, red snapper, Spanish mackerel, pike, and barracuda. None of these products are exported. On the two large lakes, Managua and Nicaragua, there is a more or less permanent industry of salting fish, locally called sardines, in a similar manner. These are small fish, about 4 inches long, which when salted are sold in the market by the basket.

Fish products imported into Nicaragua in 1913, 1919, and 1920.

Year and country of origin.	Salted, pickled, and smoked.			
1913.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
United States	52,373	$4,368.09		
Italy	167	20.75		
Costa Rica	79	5.00		
Other American countries	64	3.00		
Japan	110	60.50		
China	224	129.20		
Total	53,017	4,586.54		
	Salted and smoked.		Pickled.	
1919.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
United States	17,939	$3,808.25	1,696	$231.55
Spain	90	14.00		
Panama	79	21.00	143	18.00
China	26	76.35		
Total	18,134	3,919.60	1,839	249.55
1920.				
United States	39,998	7,778.33	3,450	494.00
Great Britain	79	8.79		
Spain	462	83.44		
Panama	607	79.75		
Honduras	348	75.90		
China	29	28.50		
European countries			1,659	65.00
Total	41,523	8,054.71	5,109	559.00

As will be noticed, the imports of fish products are very small, as fresh fish are obtained in abundance, and only the foreigners and a very few of the wealthier natives use imported fish of this nature. Practically all of it comes from the United States. The only way the imports of fish products may be increased is to have grocery salesmen feature these products when traveling through the country. The demand is so small that it is believed an extensive advertising campaign would not be warranted.

COSTA RICA.

LIMON.

By Stewart E. M. Millin, consul, September 9, 1921.]

The more common fish products to be had in Limon are fresh red snapper, kingfish, and mackerel scad, obtained within or in the vicinity of Limon Harbor by local fishermen from native-made boats during calm weather, using hooks and lines. Occasionally lobsters or shrimp are obtained, but few of these find their way to the local market. The supply of fish caught in these waters is too small to meet the demand of the inhabitants. None of the fish is preserved and none reexported.

Codfish, salmon, and tuna are imported from the United States and sold locally in various stores, but there are no statistics available here as to quantity. These figures may usually be had through the consulate in San Jose, in which city the various customs figures are preserved. The demand for salmon and tuna here, while small, is steady and is slowly increasing.

SAN JOSE.

[By Henry S. Waterman, consul, November 15, 1921.]

The fish caught in this district are those common to these waters, such as red snapper, barracuda, Spanish mackerel, etc. There is no regular fish-curing industry, although fish are occasionally cured for consumption in the interior of the country and for holy week. This curing consists simply of splitting the fish in half and hanging in the sun. No fish are exported. The statistics for imports of fish for 1920, compared with 1914, are as follows:

Product imported and country of origin.	1914			1920		
	Pounds.	Normal exchange value.	Present exchange value.	Pounds.	Normal exchange value.	Present exchange value.
Codfish:						
United States	530,431	$39,973.73	$22,350.90	426,131	$68,056.94	$38,053.34
United Kingdom	151,323	9,749.19	5,451.16	62,498	11,552.93	6,459.70
Germany	102,905	8,779.67	4,909.06			
Other countries	299	34.41	19.24	1,547	351.08	196.30
Total	784,958	58,537.00	32,730.36	490,176	79,960.95	44,709.34
Dried fish:						
United States	42,504	4,200.81	2,348.84	82,027	14,012.31	7,834.84
United Kingdom	1,256	95.79	53.56	58,287	4,463.07	2,495.48
Other countries	1,267	292.02	163.28	1,725	891.87	498.68
Total	45,027	4,588.62	2,565.68	142,039	19,367.25	10,829.00
Preserved fish:						
United States	240,370	14,884.19	8,322.34	698,403	96,288.95	53,838.98
United Kingdom	52,360	3,160.14	1,766.96	38,625	11,498.99	6,429.54
Germany	57,779	6,115.68	3,419.52	304	154.38	86.32
Spain	69,986	7,024.29	3,927.56	62,099	13,138.58	7,346.30
France	24,033	3,025.76	1,691.82	16,276	5,361.92	2,998.06
Other countries	6,206	772.83	432.12	13,035	9,754.77	5,454.28
Total	450,734	34,982.89	19,560.32	828,742	136,197.59	76,153.48

NOTE.—In the above table the figures for the United States include American goods reexported from Panama to Costa Rica. The normal value of the colon is 46½ cents, at which rate all statistics are compiled, but at present it is worth about 26 cents.

Although the consumption of imported fish is normally large for a country of less than 500,000 population, the imports in 1920 were abnormally large. This was due to the high prices of coffee from 1918 to 1920, which brought considerable wealth into the country, and also to the fact that duties on all canned goods were to be raised, which resulted in the placing of large orders in order to retain the advantage of the low duties. A large importer of these products states as his opinion that the coming years will not exceed 50 per cent of the amount imported in 1920. The principal variety of fish imported is codfish, which comes in tins and boxes containing 25 pounds each and in boxes containing 25 paper packages of 1 pound each. Other dried fish is imported in kegs of from 25 to 100 pounds, and fish in brine comes in kegs of 8 and 12 pounds and in tins of 10 and 25 pounds.

No fish products are imported for reexportation, as this would be impracticable because of the high duties. The duties are per kilogram gross weight and are payable at the gold value of 46½ cents for one colon. As a consequence, all packing should be as light as

possible, consistent with safety. As the greater proportion of fish products imported come from the United States, it would seem that there is not a preference for foreign goods. The English products are preferred by their own nationals, and some of the high-class French and Spanish products are liked on account of the quality of the oil in which the fish are preserved. It is not, however, believed that American fish packers need fear foreign competition in Costa Rica.

The only practical manner of increasing the consumption of American fish products in Costa Rica is to have salesmen call on the principal importers as part of a more extended trip through Latin America. They could then appoint agents and determine which is the best method of advertising their goods. It is further suggested that in order to obtain large initial orders salesmen should time their visit before Lent, as that is the period of the year when the largest amount of dried fish is consumed.

PANAMA.

COLON.

[By Julius D. Dreher, consul, September 7, 1921.]

In this consular district fish are caught with hook and line and also with nets to supply in part the local demand of the market in Colon, but no fish are cured here. The only fishery product exported from Colon is tortoise shell, which was exported in 1920 to the value of $49,562.

Fishery products were imported in 1919, according to the latest statistics available, to the amount of $113,255, for the entire Republic of Panama. Of this amount the United States furnished products to the value of $103,353, or 91.3 per cent. The remainder, $9,905, was furnished by other countries, as follows: China, $4,312; England, $2,876; Japan, $1,932; other countries, $785. The products imported from China were special articles for Chinese residents of the Republic. The fish products entered at Colon amounted to $38,226 and at Bocas del Toro to $30,026, a total for this consular district of $68,252, or 51 per cent of the total for the country. The official statistics do not show the reexport of any fish products.

PANAMA.

[By George Orr, consul, December 20, 1921.]

Edible fish are quite plentiful in the waters of Panama, but the fishing industry has not been developed further than the direct sale of fresh fish to the consumer from the boats of the fishermen or the public market. A number of the inhabitants are fishermen by occupation, but the supply of fresh fish obtained is altogether inadequate to the demand, and considerable quantities of dried and canned fish are imported annually. There are no local dealers in fresh fish other than the fishermen at the beach or in the market and no industrial establishments engaged in the preparation of fish products.

Official statistics of imports published by the Statistical Bureau of the Republic of Panama are not available for any period later than the first six months of the year 1920. Import statistics show 90 per cent or more of shipments of fish received as having come from the United States. The proportion of such shipments actually originating in Nova Scotia or Newfoundland and transshipped through American ports to Panama can not be readily determined, though it is probable that considerable quantities of cod, mackerel, and

salmon are obtained in this manner. During the present year shipments of cod have been received direct from Halifax, but much larger quantities of Halifax cod, mackerel, and salmon are still bought through commission houses in New York. Imports from various countries during the years 1918 and 1919 and the first six months of 1920 were as follows:

Product imported and country of origin.	1918		1919		First six months, 1920.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Codfish:						
United States	484,704	$63,576	412,386	$63,157	194,300	$27,069
United Kingdom			3,991	1,271		
Japan					5,364	729
Spain					220	67
Total	484,704	63,576	416,377	64,428	199,884	27,865
Cuttlefish or squid:						
United States			7	2		
Spain			319	122	158	57
China	348	117	1,373	494	537	353
Japan			158	48	282	103
Total	348	117	1,857	666	977	513
Dried fish in general:						
United States	9,073	1,927	14,137	1,992	4,759	925
Columbia	1,078	96	605	79	541	90
China	2,374	568	5,177	1,236	1,558	556
Japan	1,685	479	1,210	473	836	219
Total	14,210	3,070	21,129	3,780	7,694	1,790
Fish in sauce in general:						
United States	1,742	313	24,928	4,099	28,897	5,717
United Kingdom					4,336	1,433
France					154	135
China	1,725	258	1,591	484		
Total	3,467	571	26,519	4,583	33,387	7,285
Herring:						
United States	81,292	8,028	36,117	4,070	15,257	1,398
United Kingdom			1,368	773	7,568	1,089
Total	81,292	8,028	37,485	4,843	22,825	2,487
Mackerel:						
United States	82,504	11,885	38,062	5,241	11,823	1,331
France			48	44	31	12
Total	82,504	11,885	38,110	5,285	11,854	1,343
Roe:						
United States	31	15	22	5		
China	10,888	451	9,203	606	5,025	659
Total	10,919	466	9,225	611	5,025	659
Salmon:						
United States	110,288	6,579	32,809	4,935	191,809	38,296
Japan					53	22
Total	110,288	6,579	32,809	4,935	191,862	38,318
Sardines in oil:						
United States	113,740	20,986	26,796	5,266	46,246	8,038
United Kingdom					1,115	611
Spain	495	131			202	60
France			416	333	873	357
Total	114,235	21,117	27,212	5,599	48,436	9,066
Sardines in sauce:						
United States	106,209	13,424	5,623	1,392	36,344	6,800
Spain			440	128	255	96
France					112	22
Total	106,209	13,424	6,063	1,520	36,711	6,918

Product imported and country of origin.	1918		1919		First six months, 1920.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Sardines, dry:						
United States	1,597	$239				
Spain					114	$38
Total	1,597	239			114	$38
Shellfish in general:						
United States	348	115	1,335	$508	106	4
Japan	794	130	1,135	151		
China	196	88	532	190		
Total	1,338	333	3,002	849	106	4
Shellfish, preserved:						
United States	21,892	7,141	57,044	12,516	25,227	4,104
United Kingdom			5,544	842	7,066	1,600
Japan	7,009	1,580	5,867	1,261	9,121	2,269
China	4,886	801	5,447	1,412	2,119	751
Spain	1,496	290	92	30	915	501
Italy			77	48		
France					99	44
Colombia	44	5				
Total	35,327	9,817	74,071	16,109	44,547	9,269
Miscellaneous:						
United States	51	14	4	2		
Spain			31	20	114	38
France			9	11		
Holland					4	7
Total	51	14	44	33	118	45

General figures recently published by the statistical bureau of Panama show total imports of fish for 1920 to have been 1,057,604 pounds, valued at $177,625, and for the first half of 1921 to have been 601,729 pounds, valued at $66,385. A larger proportion of fish and fishery products is imported from the United States than the general average for all commodities. Some shipments of dried fish and shellfish, insignificant in comparison with total imports, are obtained from China and Japan, and small quantities of certain fish products not obtainable in the United States are imported from other countries.

The varieties of fish most in demand are cod, salmon, sardines, mackerel, herring, and preserved shellfish, the last item including principally shrimp. Cod, mackerel, and salmon in barrels are obtained chiefly from Halifax through commission agents in New York. Salmon in cans is mostly shipped from San Francisco and sardines in cans from San Francisco and New York. Shrimp in cans and dried shrimp in barrels come principally from New Orleans.

The preference shown for Halifax cod, mackerel, and salmon is due mainly to their being cheaper than American products, prices being about $10 less per barrel, although it is claimed by local dealers that the Halifax cod is of a quality which sells better in this market. Halifax cod contains the bone and is purchased dried in barrels of 300 pounds. Boneless cod of the description sold largely in the United States is stated to be unsuited to the requirements of the local market. The present price of Halifax cod, shipments of which have recently been received direct, is about $30 per barrel of 300 pounds, c. i. f. Panama. There is no reexport trade in imported fish products in this consular district.

SOUTH AMERICA.

COLOMBIA.

SANTA MARTA.

[By Leroy R. Sawyer, consul, September 13, 1921.]

In this consular district, comprising the department of the Magdalena, the principal fishing centers are the bays on the north coast, the large swamp traversed by estuaries (Cienaga Grande) forming a part of the delta of the Magdalena River, and the same river serving as the western boundary of the department.

From the Santa Marta Bay and Taganga Bay, lying to the northeast, bonito, picúa, sierra (saw fish), and pargo (red snapper) are obtained in considerable quantity, the first two, however, in greater abundance. The sábalo is also occasionally brought in. In the Cienaga Grande the catch consists chiefly of lisa, bágre (catfish), mojara, and libranche, a fish the flesh of which contains a large percentage of oil. It has not been possible to obtain any data relating to the fishing industry for municipalities situated on the Magdalena River proper. Those municipalities are, furthermore, almost exclusively dependent upon Barranquilla for such fish products as may be imported, and data in this connection would be reported by the consulate in that city.

The bonito and picúa are seined, and the sierra and pargo are caught by hook and line. The greater part of the catch obtained in the Cienaga Grande is secured by the use of the circular bell-shaped net, the usual procedure being for a fleet of fish boats to select a designated fishing ground and nets being cast to cover the area chosen. The sábalo is usually harpooned. It is probably safe to say that several thousand people in and around the Cienaga Grande devote themselves to fishing for a livelihood. In fact, the residents of Salamanca (the long ribbon-shaped island facing the Caribbean Sea), Pueblo Viejo, Isla Rosario, El Morro, Buena Vista, and Trojas de Cataca, towns and settlements located on the shores of the Cienaga or built out over the water or situated on islands within the Cienaga, are almost entirely fishermen. Fishing is free of any governmental restriction throughout the department of the Magdalena except in the case of the municipality of Pueblo Viejo, located on the shores of the Cienaga, in which instance the fishing rights are subject to taxation when the industry is carried on for commercial purposes. During 1920 the sum of 5,477 pesos, Colombian currency, was collected on this account.

All the fish in this district, except the lisa, are put on the market and consumed the same day they are caught. The lisa is split open cleaned, salted, and sun dried, and in this form becomes an article of considerable trade with Barranquilla and other cities and towns located on the lower Magdalena River. No fishery products are exported. There is, however, a fair amount of interdepartmental trade in fish, lisa principally, particularly between this and the adjoining departments of Atlantico and Bolivar.

No separate statistics covering imports of fishery products are kept at the local customhouse, but approximately correct data have been obtained from the principal local merchants handling such goods. This information follows:

Kinds.	Quantity imported monthly.	Retail price.[1]	Countries of origin.
Salted codfish, dressed cut	150 cases of 20 pounds	35 centavos per pound	United States.
Canned sardines	20 cases	15 to 40 centavos per 4-ounce tin.	United States, France, Norway.
Canned salmon, pink and red.	10 cases	35 to 50 centavos per pound can.	United States.

[1] Retail prices stated in Colombian currency—100 centavos or 1 peso equals 86 cents, United States currency, prevailing exchange.

The only fish product imported from countries other than the United States is canned sardines. The French and Norwegian brands can be obtained in choicer varieties than is the case with similar American products, so local dealers state. There is no reexport of imported products from this district.

In view of the importance of the fishing industry at this and near-by points, as well as the relative cheapness of local fishery products as compared with those imported, it is doubtful whether much additional impetus can be given to the introduction of such products from the United States. The interior districts of Colombia, however, are unable to obtain fresh fish from the coast and should offer unusual opportunities for trade extension in this line of goods, provided the needs of the consumers and dealers in those sections of the country can be ascertained and satisfied.

BARRANQUILLA.

[By Edmund B. Montgomery, vice consul, December 9, 1921.]

Fish products constitute a very important part of the daily food consumption of this vicinity. Sea fish from Puerto Colombia and Salgar are in the greatest demand, though a kind of river fish known as "lisa" is consumed in large quantities by the poorer classes. It is estimated by the department of statistics that about 1,000 pounds of fish arrive at the market in Barranquilla daily from various sources. The principal products for local consumption are sea fish known as lebrancho, robalo, mojorra, sierra, chivo, bonito, and the river fish lisa. Most of these are consumed shortly after being caught, though a considerable amount of salt fish is also sold. In addition to fish other sea food, such as crabs, lobsters, shrimp, and oysters are also sold in varying quantities. Sea fish are caught at Salgar and Puerto Colombia, the former being 14 and the latter 17 miles by rail from Barranquilla. These fish are brought daily to the Barranquilla market for sale.

River fish are caught in the Magdalena River by native fishermen and brought in canoes to the market, which is connected by a canal with the river. Fish may be bought either from the market or from canoes and other small river craft which line up along the banks of the canal at the market. Fish bought directly from the river boats can be obtained at slightly lower prices than those prevailing in the market. The river fish "lisa" are sold at 5 cents each, or in quantities for 2 and 3 cents each. Fish products are crudely cured by cleaning, salting, and allowing to dry in the sun for about two days. Cured in this manner they keep for about two weeks. Most fish, however, are sold shortly after being caught, without being cleaned

or cured. No packing of fish products is carried on and none are exported.

The following table shows the value of fish products imported through the customhouse at Barranquilla during the first six months of 1920. Later statistics are not available.

	United States.	Spain.	France.	England.	Italy.
Dried and salted	$678				
Pickled	3,989	$20			
Canned	115,040	59,957	$16,997	$7,396	$2,976

There is no established reexport trade. The principal competitors of the United States in canned fish are Spain, France, England, and Italy. The United States exported to Colombia, through Barranquilla, during the first six months of 1920 more canned fish than all other countries combined, furnishing $115,040, or 56 per cent, of a total of $202,366, or about twice the amount received from Spain, the strongest competitor. One Barranquilla house ships about $200 worth of French sardines per month into the interior.

The reasons for part of the demand being supplied by other countries are as follows: (1) Connections had been established before United States actively entered the market. (2) Considerable numbers of dealers are nationals of Spain, the strongest competitor of the United States; (3) Sardines from Spain and Italy sell for 15 cents per can, while the cheapest American sardines are sold at 20 cents. Better grades of Spanish sardines sell at 25, 30, and 45 cents, and Italian sardines sell at 15, 20, and 25 cents.

The sale of American canned fish might be stimulated by correspondence, which should be in Spanish. Appointment of representatives to handle sales in the interior should prove of considerable benefit, though in this vicinity there are no American firms handling food products and but one American, who is a manufacturer's representative, handling food products. It is possible that sales in Barranquilla might be stimulated by advertising.

CARTAGENA.

[By E. C. Soule, consul, November 24, 1921.]

The fishing industry in this consular district is limited to the supplying of fresh fish to the local market. The fish are salt-water fish, caught by the native fishermen by seining, trawling, and dynamiting. The latter method is illegal, but it is believed to be in rather general use. Dried shrimp constitutes about the only fish product, and these are not put through any special process other than being dried in the sun. There are no exportations of fishery products from Cartagena and no reexport of imported products.

The importations of salmon, sardines, and cod for the year 1920 are given in the following table:

Product.	United States.		Spain.		France.		Great Britain.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Salmon	112,356	$16,691					70	$11
Sardines	114,704	18,964	36,582	$9,025	6,862	$2,250	7,018	1,607
Cod	4,499	1,014						

The Spanish sardine is now offering the keenest competition with the American product, and its importation has been increasing. It is palatable to these people and cheap, retailing in small tins at 10 cents each. American fishery products should be marketed here through the established dealers in groceries and provisions. The people like American food products but find them usually expensive after freight and duty on gross weight have been paid.

ECUADOR.

GUAYAQUIL.

[By Frederic W. Goding, consul general, September 2, 1921.]

The principal local fishery products of this district are fresh and dried fish, large crayfish, eels, oysters, prawns, pearls, and tortoise shells, while in the ocean some whales are captured by Norwegian whalers. Also, there are two kinds of seals, both the fur and hairy varieties, to which no attention is paid. The methods employed in obtaining these products are similar to those utilized for the same purpose in the United States, with the exception that in obtaining fresh fish near Guayaquil the water in the inlets is poisoned with a pulverized nut called barbasco, which stupefies the fish but does not injure them as food.

Fish are the only products preserved, the preserving being done by cleaning and salting the fish and drying them in the sun in the most primitive manner. This industry is carried on mostly in the vicinity of the ports of Manta and Salango.

The only products of Ecuadorean fisheries exported are pearls and tortoise shells, the value of which varies greatly in different years. While the fishery products imported into Ecuador are not important they deserve attention. The imports for the years 1913, 1914, 1915, and 1916, compiled from the official statistics, are given in the following table:

Product imported and country of origin.	1913	1914	1915	1916
Cod:				
United States	$114	$2,550	$3,740	$4,262
United Kingdom			2,059	
France	8			45
Germany	5,278	6,448		
Italy	53			
Norway				2,990
Peru			1,840	
Spain			11	
Sweden			7,002	
Total	5,453	8,998	14,652	7,297
Canned salmon:				
United States	9,520	13,150	14,836	18,465
Germany	122			
Italy			273	
Panama			9	
Spain			265	8
Total	9,642	13,150	15,383	18,473

Product imported and country of origin.	1913	1914	1915	1916
Dried salted fish:				
United States	$2	$357	$950	$743
China	437	146	380	92
France	18		116	
Italy	43	53	31	
Japan	68	55	269	649
Peru	255			1,024
Spain				20
Total	823	611	1,746	2,528
Sardines:				
United States	3,510	32	2,789	5,450
United Kingdom	925	23	2,197	757
Belgium	79	204		
France	1,695	715	2,212	929
Germany	8,272	9,457	220	
Italy				200
Panama		220	461	412
Spain	7,084	28,240	17,497	19,114
Total	21,565	38,891	25,376	26,862

It will be noted that in 1913 the United States enjoyed nearly 38 per cent; in 1914, 26½ per cent; 1915, 39 per cent; and in 1916, 52½ per cent, or an average of 34 per cent of the fish trade of Ecuador for the four years mentioned. Besides these imports, under the heading "Unclassified conserved animal food," appearing in the published statistics, about $50,000 worth of products are mentioned as imported annually, among them being some fish, oysters, shrimp, and lobsters, which, however, can not be separated.

The imports for four months of the year 1920 are given in the following table, which has been compiled for the purpose of showing the value of the more recent trade in fishery products, in which it is shown that 86 per cent of the imports were from the United States. None of the imported fishery products are reexported from Ecuador:

Products imported.	United States.	Spain.	United Kingdom.	France.	Norway.	Italy.	Panama.	Japan.	Chile.
	Value.	*Value.*	*Value.*	*Value.*	*Value.*	*Value.*	*Value.*	*Value.*	*Value.*
Cod	$5,499		$2,918		$1,386				
Caviar	557			$108					
Fish, canned	6,274	$448	42	76		$124	$481	$86	
Lobsters and crabs	420			15				45	$240
Oysters	255			7			52	86	
Salmon	73,541					915			
Salted fish	1,629								
Sardines	55,065	12,665	1,087	2,256					
Shrimp	600						32	110	
Tuna	704			44					
Total	144,544	13,113	4,047	2,603	1,386	1,039	565	327	240

PERU.

CALLAO-LIMA.

[By Fred D. Waddell, vice consul, November 4, 1921.]

The fish most used in Peru are the corvina or corbina, the lisa, the lenguada, and the pejerrey. Of these the corbina is the most useful, as it attains a large size and is of fine and pleasing flavor. This fish is similar to the salmon found in northern waters, ranges in size from 3 to 30 pounds, and is found in enormous quantities off the Peruvian coast. It may be cooked in any manner and is a regular item in all meals in every Peruvian home and in the hotels and restaurants. The lisa and the lenguada are also excellent fish, attain quite a large size, and are used a great deal. The pejerrey, or "Fish of the Kings," is a small fish similar in size and flavor to the American smelt and is considered a great delicacy. It is found in enormous numbers and at all seasons of the year.

In addition to the fish above named and described as those most used, there are many others suitable for food which are in daily use. Also, there are many fish which are not used as food but which might be utilized. In the northern part of the Peruvian waters, in the vicinity of Tumabez, for instance, great numbers of sharks abound, which are never eaten, as the supply of other edible fish is so great that they are not needed.

Several varieties of shellfish are found on the Peruvian coast, the principal ones of which are the cameron and the conchita. The

cameron is known as the Peruvian shrimp. It is identical in shape and size with the crayfish found in great numbers in some parts of the United States. This shellfish can be found at all seasons of the year in great quantities and is much used. It is excellent for salads, as its meat is of fine flavor. It is also said to be susceptible of canning and preserving in the same manner as shrimp. The conchita is a bivalve and is found only in limited quantities. It has a beautiful shell, brown on the outside and white inside. These shells are all uniform, but they are of no value except for ornamental purposes.

The meat, however, is delicious, either cooked or raw. It is in two parts, one part, attached to the shell, being firm and white and similar in taste to the scallop, the other part being a very small scarlet tip of soft substance. These shellfish are very delicate and must be eaten very soon after gathering, as they spoil very easily. There are several other varieties of shellfish found, but they are very little used. Some of them are bivalves and some crustaceans.

The methods used in obtaining fish in Peru are the most primitive. For the offshore fish, such as corvina, bonita, lisa, etc., hooks and lines are used, either in anchored boats or trailing from moving sailboats. For the smaller fish caught near the shore hand nets are used. The lines used offshore have several hooks to the line. The largest boats used are not over 3 tons, and these are only exceptional. The majority are simply small sailboats, which very seldom go out over 10 miles from the shore. Canoes even are used, and occasionally the ancient raft may be seen. The fishery industry is essentially coastwise.

There is no canning industry in Peru, and neither is there any refrigeration, so that the fish caught are eaten at once or thrown away when they become spoiled. However, in the northern part of the Republic, in the vicinity of Pimentel, San Jose, and Paita, a small quantity is salted. They are dried in shady places, and in some instances a one-fifth part of saltpeter is added. The amount thus cured does not exceed 12 or 15 tons per year at the most.

Because of the lack of canneries, refrigeration, and facilities for curing no fishery products are exported from Peru, except in very small quantities, to neighboring countries, consisting of salt fish alone. These exports are as follows:

1915. To Ecuador 312 pounds, salt fish, value $10.
1916. To Chile 231 pounds, and to Ecuador 304 pounds, salt fish, total value $41.
1917. None.
1918. To Bolivia 116 pounds, salt fish, value $29.
1919. To Bolivia 179 pounds, salt fish, value $45.

Quite a large amount of fishery products is imported into Peru. The principal preserved fishery imports are sardines, differently preserved, salmon in tins, tunny fish, herring, eel, stockfish, lobster, oysters, crabs, and several other kinds. There are also a number of different kinds of pickled fish imported.

Following are the statistics showing the amounts of the different kinds of fishery products imported into Peru during the years 1913, 1917, 1918, and 1919 and the countries of origin. The year 1919 is the latest for which these statistics are available.

Country importing.	1913				1917			
	Fish, pickled in wooden containers, and dried or smoked fish not in tins.		Fish, in tins, china, or glass, and dried or smoked fish in tins.		Fish, pickled in wooden containers, and dried or smoked fish not in tins.		Fish, in tins, china, or glass, and dried or smoked fish in tins.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Brazil							134	$25
Chile	1,931	$51	64	$3	1,849	$204		
France			326	14				
Germany	8,902	236	320,450	14,132				
Great Britain	125	3	23,100	1,019			4,564	856
Hongkong	6,019	160	4,302	190	5,307	585	3,275	614
Italy	2,422	65	1,434	63				
Japan	592	16	1,792	79	18,172	2,003	37,990	7,121
Norway							13,614	2,552
Portugal	4,132	109	791	35			687	129
Spain	172	5	242	11	40	4	381	71
United States	672	18	3,263	144	46,291	5,103	180,377	33,808
Not specified					9,153	1,009	20	4
Total	24,967	663	355,764	15,690	80,812	8,908	241,042	45,180
	1918				1919			
Bolivia			53	$10	198	$21		
Brazil	11,141	$1,228			9,505	1,048		
Chile			3,085	578	131	37		
Great Britain							1,875	$351
Hongkong	7,335	809	4,333	812	2,637	180	2,078	390
Italy							1,314	246
Japan	23,631	2,605	118,064	22,127	47,538	5,241	111,912	20,975
Portugal					66	1	107	39
Spain			2,021	379	218	24	234	44
United States	60,841	6,708	106,642	19,988	9,675	1,066	115,361	21,622
Not specified	1,712	189			1,278	141		
Total	104,660	11,539	234,198	43,894	71,347	7,759	232,881	43,667

None of the fishery products imported into Peru are reexported. The American fishery products, such as sardines, canned salmon, dried cod, etc., predominate in this market, and when any of such products are imported from countries other than the United States it is not because of better quality but is simply a matter of price. It is true that some varieties of canned fish are imported from other countries on account of being prepared and preserved differently from those produced in the United States, but, on the whole, the American goods are the most popular, and when two articles of the same class and kind are presented for sale—one from the United States and the other from another country—the American product is generally chosen.

Recently the price of American canned fishery products has been higher than the price of foreign goods of the same kind, and on account of the low rate of exchange between Peru and the United States there has been comparatively little importation of the American products. Thus these two elements are the real ones that make competition with other countries difficult and are the cause of these goods being bought in countries where they can be produced and sold at a cheaper price. Of course, such articles as a certain kind of fish, preserved and packed in a way peculiar to a certain country, are imported only from that country. The above statements do not refer to that class of goods, however, but to fishery products that are

common to all trades and that have come to be staple articles of diet in practically all countries.

The American exporter of fishery products should, first of all, endeavor to retain the high quality of his goods for which American goods of this class are now known and should not try to force an inferior article on the market at the same price. Next, strict attention should be paid to packing, which should be strong enough to withstand the handling it will have to undergo when shipped to the west coast of South America, where most of the unloading is done in lighters, since practically all the harbors are open roadsteads.

The terms upon which these, as well as other classes of goods, are sold in Peru are generally cash against documents. During the war, and at a time when the European countries could not compete with the United States, the United States obtained a large advantage in this trade, but now that the countries of Europe are beginning to export, better credit terms are being offered, and unless the American exporters can devise some method of being able to meet these credit terms it will be a difficult matter for them to meet the European competition.

It is therefore thought that if American exporters will meet the terms of the other countries in regard to the above-mentioned matters and let this fact be known among the Peruvian importers it will have a tendency to increase trade between the two countries to a considerable extent. Complaint has been made of the inferior packing by American exporters, that goods received do not come up to sample, and that where American firms require cash payments European and other firms extend reasonable credits. These matters are given a great deal of consideration by the Peruvian buyer, and they should also be considered by the American exporter.

A summary of the possibilities of the fishing industry in Peru is that hitherto there has been no local interest in the development of this industry, but recently the Peruvian Fisheries Department has been trying to evolve a plan of increasing its fishery products. As to the possibilities of this industry, it may be said that they are many and great. There are no canneries in Peru and no facilities for refrigeration or for curing fish. The waters of the Pacific Ocean off the coast of Peru literally teem with fish of many kinds, a great number of which are of very fine food quality and undoubtedly suitable for canning, preserving, and curing. Good indications of the quantity are the vast number of fishing birds which inhabit the coast and the islands of Peru and the fact that the supply of fish used by the human population must be obtained daily and with a great loss of the fish caught, since facilities for keeping those not consumed are lacking.

The equipment for obtaining the fish is primitive, and undoubtedly if modern methods and equipment were employed the catch could be enormously increased. Should canneries and refrigeration facilities be installed, this catch could be preserved for marketing, not only in Peru but in the other parts of the world. Undoubtedly this is one of the industries that in the future will be seen in operation to a great extent along the west coast of South America.

CHILE.

IQUIQUE.

[By Homer Brett, consul, September 14, 1921.]

Fish products produced near Iquique consist solely of fresh fish taken principally with hook and line from small boats. There is some seine fishing, and swordfish, known locally as "albacore," are killed with harpoons. These are remarkable for the large amount of clear meat they yield and the small quantity of waste matter. There is no doubt that this fish would be most excellent for canning. When the catch of fresh fish is unusually abundant or is made at places distant from markets, it is salted lightly, but there is never any exportation nor even shipment to other points in Chile. In central Chile the question of establishing a national fishing industry is one of perennial discussion, and many articles, all favorable to the enterprise, have been published in the newspapers of Santiago, but thus far little or nothing has been accomplished.

The imports of fish products into Iquique have been as follows, the latest years for which statistics are available:

Fish products imported.	1917		1918		1919	
	Kilos.[1]	*Pesos.*[2]	*Kilos.*[1]	*Pesos.*[2]	*Kilos.*[1]	*Pesos.*[2]
Shellfish			8,508	20,114		
Fish, dried or salted	15,115	14,941	44,050	45,257	5,755	7,891
Canned lobster			251	600	25	58
Canned fish and shellfish	3,764	4,789	9,346	17,317	5,592	6,608
Canned salmon	80,104	34,486	80,065	44,440	31,072	19,174
Canned sardines	23,010	24,523	8,236	12,302	12,215	14,017

[1] One kilo equals 2.204 pounds. [2] The peso is the gold peso of 18 pence.

Countries of origin are not shown for the importations into the individual ports, but only for those into the entire country. From these it appears that in 1917 Japan was the principal supplier of dried and salted fish, followed closely by the United States and next by Great Britain. Norway, Spain, and Argentina supplied small quantities. In 1918 Japan led in quantity and the United States in value, and in 1919 Japan supplied half of the total in value and more than half in weight, while the United States shipped approximately one-third. In Chile, as in all Spanish countries, codfish is considered a delicacy, although cheapness is the first consideration. During 1917 the United States and Spain led in supplying canned fish and shellfish, with Italy and France following with much smaller quantities; in 1918 Spain was the principal supplier, with the United States following with considerably smaller quantities; in 1919 these relative positions were maintained.

Canned salmon comes almost exclusively from the United States, though small quantities are credited to Great Britain and Japan. Sardines came principally from Spain in 1917 and 1918, though in both years the United States competed closely. In 1919 the weight of sardines from the United States for all Chile was 159 tons and the value 152,779 pesos, while Spain shipped 157 tons, valued at 258,481 pesos.

It is almost certain that the import of American fish products into Iquique can not be increased in the near future. They are

well known and liked, but this district is in a state of profound industrial depression owing to the lack of demand for its one product, nitrate of soda. Nearly all the plants are closed down, thousands of idle laborers have been sent to the south, and business is at a standstill. The high foreign exchange makes it impracticable to import anything but the barest necessities. American exporters would do well to attempt to make only small sales, more as a matter of advertising than anything else, until the revival of business, which it is hoped will take place in 1922.

ANTOFAGASTA.

[By B. C. Matthews, vice consul, October 15, 1921.]

In this consular district local fishermen supply fresh fish. The quantities caught and sold are for local consumption and are negligible. The catch is sold the same day it reaches shore. There are no refrigeration plants here, and no part of the local catch is stored or preserved. The methods of fishing are both by nets and lines, and all the catch is salt-water fishes taken a few miles from shore. There are no exports or reexports of fishery products from this district.

In 1917 salmon to the value of 82,033 Chilean gold of 18 pence were imported at Antofagasta, the principal countries of origin in order of importance being United States, Great Britain, and Japan. In the same year dried fish to the value of 6,661 Chilean gold of 18 pence were imported, the countries of origin in order of importance being the United States, Japan, and Great Britain. Sardines to the value of 54,613 Chilean gold of 18 pence were imported in 1917, the principal countries of origin in order of importance being Spain, the United States, and France.

There is a decided preference for Spanish sardines packed in olive oil, the trade mark being "Curbera." This is an excellent product, and because of the grade of the oil used it is considered superior to any other product imported here. The major portion of the salmon importations come from the United States, and a low grade, "Chum," forms the bulk of this trade. However, there is a good demand for pink salmon here when prices are not too high. Salmon are imported from England, but the demand is not large. Dried codfish in packets of 1 pound is salable, and sometimes in tins of 11 and 23 pounds. The imports are mostly from Scandinavian countries and Japan. The Scandinavian product is good and of excellent flavor, perhaps more palatable than the Alaskan article that arrives here from San Francisco.

The wholesalers and retailers here are familiar with the different qualities of American salmon, and the increased demand for this product really rests more upon the cost to the consumer. With regard to sardines it is not believed there is much room for competition with the Spanish product unless an oil equal in quality is used in the preservation of small sardines. The larger sardines put up in 1-pound oval tins, packed in California, have established themselves in this market, apparently to stay. It would seem that fish packers on the Pacific coast should keep in constant touch with this market through their exporting houses in San Francisco, and for the grades of sardines packed in cottonseed oil on the Maine coast packers

should likewise keep in close touch with the exporting firms in New York City. Besides canned fish there are usually large importations of dried shrimp in barrels, mostly from New Orleans, La. There should be a growing demand here for this product, depending to a great extent upon the market price at that port.

VALPARAISO.

[By Edwin H. Livingstone, vice consul, December 9, 1921.]

In the territorial waters of Chile, in the neighborhood of the thirty-eighth parallel, the center of which is the port of Lebu, south of Talcahuano, there is an abundance of edible fish and shellfish. To date the fishing industry in this section exists in a crude and ancient state on a small scale. Deep-sea fishing has not been inaugurated, as no company has undertaken this task with sufficient capital to carry it through to a successful business. The fishing industry employs but 3,350 fishermen, or about 8 per cent of the population of 4,000,000 inhabitants. It is calculated that the products of the fishing industry of Chile amount to 11,172 tons of fish a year, or 3.34 tons per person engaged in the industry.

In Chile fishing has never been prosecuted on a scientific basis but is handed down, generation by generation, from father to son, the new generation carrying on the work exactly the same as the old generation, with very little progress, consequently, in the development of the industry. The Chilean fisherman uses a small boat, manned by two or three oarsmen, and generally fishes at a distance of 1 or 2 miles from shore, and never more than 4 or 5 miles. The majority of the fishermen use rowboats, very few boats being equipped with steam engines or motors. The industry is so small that it is far from adequate to meet the demands of the home market, resulting in an enormous difference between the prices at the point where caught and the final retail price in the cities. The following table will demonstrate this difference, taking as a basis the prices of the products on the island of Santa Maria, one of the industrial centers of the Chilean fishing industry. The prices are based on the metric quintal of 101 pounds.

Species.	Prices at Santa Maria.	Prices at Santiago.	Species.	Prices at Santa Maria.	Prices at Santiago.
	Pesos.	*Pesos.*		*Pesos.*	*Pesos.*
Congrio colorado	36	250	Lisa	48	230
Congrio negro	24	120	Cabinza	18	80
Corvina	40	250	Tollo	8	80
Robalo	36	150	Vieja	8	65
Rollizo	36	100	Loco	12	90
Jurel	24	90	Erizo	12	85
Cabrila	24	100	Choro	15	60
Lenguado	60	250	Piure	6	50
Pescada	9.6	40			

In this large difference that is observed in comparing the cost price and the retail price the railroad rates are not the influence that cause the high price, as might be thought, but the scarcity of fishermen and the small production against demand. The small retailers of fish and shellfish sell their stocks at very high prices,

taking advantage of the scarcity of fresh sea food, even going to the extreme of closing their doors to the public and refusing to sell their fish when by some unavoidable influence the prices of the fish drop and the retailer can not get the prices he is accustomed to charge the ultimate consumer.

Of the shellfish the "langosta," or lobster, has a large sale and is very popular. This lobster is to be found in large numbers on the group of islands known as Juan Fernandez Islands, including the islands of San Felix and San Ambrosio. These lobsters are usually caught at distances averaging from 1 to 3 miles from shore. In order to keep them alive, they are placed in boats, with screen bottoms, maintained afloat by air tanks, through which water is continually flowing. They are brought to Valparaiso in small fishing schooners and command an immediate sale. The demand for these lobsters is large, much larger than the supply, with the result that the retail price is very high, averaging from 8 to 10 pesos, the kilo of 2.2046 pounds. These lobsters are also exported to the Argentine, where they command a price from 12 to 15 nacionales. This is a very high price, but the class of the lobsters is such that they find a ready sale. To date this industry has been exploited only on a small scale, although periodically the newspapers publish notices of the prospective formation of companies that are going to carry on the industry on a large scale. However, nothing as yet has materialized.

Of the mollusks the small oyster, found in abundance in the southern part of the country, commands a large sale. Artificial oyster beds have been cultivated in this region, and these oysters are brought to the north, where they are sold in the city of Santiago for 60 pesos per box, containing from 150 to 200 oysters. Following the oyster in importance is the "choro," or red clam, which is to be found in abundance in the north as well as the south of the country. Annually this industry yields approximately 80,000 sacks, which command 34 pesos per sack in the city of Santiago, the sack containing 220 pounds. The seaweeds denominated "cochayuyo" and "cuyotallo" are eaten by the poorer classes in considerable quantities.

The city of Talcahuano has a cold-storage plant for the preservation of fish, with a capacity of 8 tons of frozen fish daily and the same storage capacity. Santiago has a cold-storage plant with a capacity of 8 tons of fish daily and storage facilities for 15 tons. Coquimbo and Antofagasta also have cold-storage plants with unknown capacities.

Codfish are imported into Chile in tins of 5 and 10 kilos each, or 11 and 22 pounds. The 1-pound tins are not a size that would sell readily in this market, as the 5 and 10 kilo tins have met with a much more ready sale, and the trade has been cultivated to that size tin. The codfish are shipped in cases of four tins, of 10 kilos each, from Norwegian ports, and eight tins, of 5 kilos each, from Japanese ports. There appears to be some antipathy toward both the Japanese and American codfish in this market, due to the repeated arrivals of shipments in bad condition. Both the Japanese and Norwegian cod sell at approximately 50 pesos gold (one peso equals 36½ cents United States gold) per case of 40 kilos, or 88 pounds. This is the present market price, but a few months ago the price was up to 85 and even 100 pesos gold per case of 40 kilos. No

codfish have been imported into the country in any amounts for some six or eight months. At the present time the demand is very small and everybody seems afraid to buy.

The season for codfish in Chile is between the months of April and August, and it is thought that one of the chief reasons for the lack of importation is due to the fact that the past season proved a failure, as very little demand was made on codfish, with the result that the market is cautious as to stocking for the coming season. On the basis of 50 pesos gold per case of 40 kilos the present market price of codfish is about 21 cents United States gold per pound. From inquiry it appears that the only reason foreign brands of codfish, etc., are preferred is because of the lower price, combined with the fact that importers are afraid to risk bringing in American cod due to the arrival of shipments in bad condition.

CONCEPCION.

[By Doyle C. McDonough, consul, November 22, 1921.]

Fish are very plentiful in the rivers of the southern part of Chile and in the neighboring ocean, although the number of species is said to be small. The fisheries are unorganized and supply only the market of Chile. The principal fish which are extensively caught and eaten are the following: The "congrio," including the red "congrio" (*Genypterus blacodes*) and the black "congrio" (*Genypterus chilensis*), the "corbina" (*Cilus montti*), the "pejerrey" (*Atherinchthys regia microlepidota* and *A. mauleanum*), the "robalo" (*Eleginus maclovinus* and *E. punctipennis*); and the "lisa" (*Mugil cephalus*, *M. rammelsbergi*, and *M. curema*). These fish exist in great abundance and are excellent for table consumption. There are several other varieties which are not considered so good for food, but are abundant and are also consumed as food. Among these latter are the fish which are known as the "pescada" (*Merluccius gayi*). Of these fish the "pejerrey," the "lisa," and the "robalo" are both fresh and salt water fish, while the "congrio," the "pescada," and the "corbina" are found only in salt water. Salmon, salmon trout, and carp, have been put in the rivers, the two former being found in fair numbers in some of the rivers, such as the Cautin River. Salmon were brought from Germany in 1905. There is a fish hatchery on the Cautin River at Lautaro, Province of Cautin, which has stocked the rivers of Southern Chile with salmon and also breeds other fish, such as carp and "pejerreys." It has been hoped that the salmon-canning industry could be established in Chile, but this seems very doubtful. Sardines are numerous at certain times of the year and are packed to a small extent at San Vicente, near Talcahuano. Dolphin and right whales are also abundant, a whale having been caught in Concepcion Bay at Talcahuano recently.

Shellfish of many kinds are numerous. Oysters of good flavor are grown near Puerto Montt and Calbuco in the Province of Llanquihue and in the waters of the island and Province of Chiloé. Mussels are very abundant and are highly regarded as food. Crabs of several kinds are found in large quantities and are highly esteemed. Several kinds of barnacles are eaten. The most important of these is the large species known as the "pico" (*Balanus psittacus*). These are

canned to a considerable extent. Sea urchins, known here as "erizos" (*Strongylocentretus albus*), are considered a delicacy.

Whaling is of some importance at Valdivia and Corral. A company having three small ships has just started business at Dichato near Talcahuano with one of its ships. The whale oil is consumed in Chile, being used mostly for lighting and by the soap factories. The Arauce Railroad, which runs from Concepcion to Curanilahne, consumes a considerable part of this oil for lighting. Considerable oil is also consumed in the soap factories at Concepcion and Coronel. Some whalebone is exported. At Talcahuano there is one old whaling ship, the *James Arnolds*, which was an old American whaler. It goes out whaling every year, although it is 50 years old. Before the American Civil War Talcahuano was a great port for American whalers. Whales seem to be numerous in the ocean off this part of Chile.

At San Vicente, near Talcahuano, there is a very small sardine-canning factory owned by Spaniards. These sardines, although cheap, have a very small sale. Owing to scarcity of tin plate and lack of sale the plant is running at about half capacity. The plant has some very good machinery and equipment. About one and one-half years ago one of the partners went to Europe to buy machinery and to study how sardines are packed.

The "Boletin de Bosques, Pesca and Caza," or "Bulletin of Forestry, Fisheries and Game," published at Santiago, in its November (1912) number, volume 1, No. 5, pages 340 and 341, states the following concerning sardines:

> In Chile we have three sardines—the *Clupea sagax*, commonly known as the Spanish sardine and which ranges in the Pacific from California to the Straits of Magellan, reaching the waters of Japan on the west; the *Clupea fueguenis* and the *Lycengraulis grossidens*, which are simply known as sardines. The second is found only in Chilean waters, being abundant south from Talcahuano, and the third in the waters of Peru, Chile, Argentina, Uruguay, and Brazil.
>
> The abundance of these species varies with the latitude. In the northern part of the country it is the *Lycengraulis grossidens*, which becomes stranded in great numbers on the beach during the spring and summer, because pursued during that time by other migratory fish, especially by the pescada (*Merluccius gayi*), the jurel (*Trachurus picturatus*), and the sierra (*Thyrsitops lepidopoides*).
>
> The Spanish sardine, whose migrations are not yet well known, does not come very close to the Chilean coast, and to fish for it it is necessary to use tackle for deep-sea fishing. The canning of the third species has already been successfully commenced in order to supplant the European canned sardine. Unfortunately in sardine canning only a small capital has been employed and the industry has lacked not only skilled workmen but also proper methods of catching the sardines.

The canning of shellfish is of importance in the extreme southern province of Chile, especially at Calbuco in the Province of Llanquihue, where there are several small canneries of considerable importance. They pack principally mussels, sea urchins, and barnacles. Their product is said to be of good quality. During the World War tin plate was so expensive that a tin can cost more than the selling price of a can of preserved seafood, and the imported salmon and sardines were sold in place of the native products. Now, with cheaper tin plate, it is believed that the canned shellfish of the southern provinces will again find a market. The local branch of an American house has taken the agency to sell the products of some of these canners in order to be able to sell them tin plate.

The island of Santa Maria, which is three hours by boat from the port of San Vicente, near Talcahuano, is one of the principal fishing centers of Chile. Fresh fish and shellfish are landed at Talcahuano, and also some fish are dried and a sort of codfish prepared. Two motor boats are employed in these fisheries. The officer in charge of the fisheries of this island and of the fisheries at and near Talcahuano in his report to the head of the Government bureau at Santiago for the months of July, August, and September, 1921, says that the fishing industry on the island of Santa Maria and at and near Talcahuano continues the same as in former years without any increase in the products; that the production of the fish known as "trite" has increased fourfold over that of the same period of former years, this increase, however, being in the preparation of smoked fish, as this fish is the one best suited for smoking. He further states that the mussels are beginning to disappear and will do so unless steps are taken to protect the beds.

In the vicinity of Talcahuano there are about 500 fishermen. They live at the small port of San Vicente or on the "Isla de los Reyes" (Island of the Kings) at Talcahuano. They seem to be very good fishermen but have only small rowboats with which to fish.

An article in La Union, of Concepcion, Chile, October 19, 1921, says that the Mocha Island, which forms part of the Province of Arauco, being opposite the Department of Canete, has fish and shellfish. Further, it states that sea lions are very abundant, 600 having been killed in about an hour, and that their oil is sold to the coal-mining companies.

Fish have become much scarcer in the rivers near Santiago, owing to the use of dynamite for killing fish and the catching of the small fish in seines of small mesh. Although the use of dynamite in the streams of the country is unlawful, it is now thought that the penalties are not sufficiently severe, and certain newspapers have advocated making them more severe. The native fish have also been greatly injured by the introduction of carp and other worthless fish that eat the eggs and young of the valuable fish. The use of the waters in the rivers for irrigation has also injured the fish.

Fish are generally caught in small nets used from small flat-bottomed boats and hand lines from such boats. Fish are also caught by fishermen on shore with lines and with nets. Seines or dragnets are operated from the shore where there are beaches. In fishing for certain kinds of fish lines with many hooks are used. The methods of obtaining shellfish and barnacles differ with the kind which is being sought, but generally are caught by hand by means of hooks or rakes. All the methods are simple and are those of fishermen that have no capital for obtaining elaborate fishing tackle or well-equipped fishing boats.

The methods of curing fish are of the most primitive, and only small quantities are cured, as fish are generally sold and eaten fresh. The fish known locally as "pescada" are dried in the sun by stretching them on the wire fences. The fish known as "trite" are smoked in very primitive smoke boxes.

Fishery products are exported from Chile in very small quantities, the principal exports being of whalebone. The following figures for 1919 and 1920 show the extent of the exportations:

Fishery products exported from Chile, 1919 and 1920.

WHALEBONE.

	1919		1920	
	Pounds.	Value.	Pounds.	Value.
PORTS.				
Coquimbo	....	....	143	$365
Talcahuano	2,552	$840	....	....
Valdivia	....	....	47,212	29,191
Total	2,552	840	47,355	29,556
COUNTRIES.				
Denmark	....	....	143	365
United Kingdom	2,552	840	47,212	29,191
Total	2,552	840	47,355	29,556

SPERMACETI.

PORTS.				
Valparaiso	8,008	$1,460	....	....
COUNTRIES.				
Japan	5,808	1,095	....	....
United Kingdom	2,200	365	....	....
Total	8,008	1,460	....	....

CANNED LOBSTERS.

PORTS.				
Antofagasta	251	$226	471	$315
Los Andes	....	....	3,150	588
Valparaiso	2,440	1,260	374	167
Punta Arenas	26,213	12,932	172	86
Total	28,904	14,418	4,167	1,156
COUNTRIES.				
Argentina	26,213	12,932	3,322	674
Bolivia	251	226	471	315
Colombia	75	11	....	....
Italy	880	365	....	....
Netherlands	62	12	....	....
Peru	1,346	806	374	167
Sweden	77	66	....	....
Total	28,904	14,418	4,167	1,156

CANNED FISH AND SHELLFISH.

PORTS.				
Arica	376	$95	2,746	$440
Antofagasta	1,254	554	2,193	606
Los Andes	1,210	66	3,432	193
Valparaiso	5,863	1,521	3,003	793
Punta Arenas	7,891	3,159	627	282
Total	16,594	5,395	12,001	2,314
COUNTRIES.				
Argentina	10,067	3,597	4,059	475
Bolivia	1,630	649	4,939	1,046
Colombia	440	183	....	....
Ecuador	660	137	....	....
Germany	....	....	66	51
Great Britain	92	73	....	....
Italy	....	....	176	39
Netherlands	48	8	....	....
Peru	2,777	602	2,761	703
United States	880	146	....	....
Total	16,594	5,395	12,001	2,314

Fishery products exported from Chile, 1919 and 1920—Continued.

FRESH, DRIED, OR SALT FISH.

	1919		1920	
PORTS.				
Arica			9,900	$1,560
Antofagasta			510	138
Coquimbo	286	$58		
Los Andes	2,037	95		
Punta Arenas			737	116
Total	2,323	153	11,147	1,814
COUNTRIES.				
Argentina	2,037	95	737	116
Bolivia			10,410	1,698
Peru	286	58		
Total	2,323	153	11,147	1,814

SHELLFISH.

PORTS.				
Arica	1,980	$748		
Antofagasta	90	27	286	$162
Los Andes	19,342	1,661	31,480	2,760
Punta Arenas	176	73	97	24
Total	21,588	2,509	31,863	2,946
COUNTRIES.				
Argentina	19,518	1,734	31,577	2,784
Bolivia	2,070	775	286	162
Total	21,588	2,509	31,863	2,946

Fish products, such as canned salmon, canned sardines, canned lobster, and dried codfish form an important item in the import trade of Chile. There is a decided preference for sardines from Europe and especially from Spain. The preference on the local market is for the small sizes, such as 180 to 190 grams gross per tin, and smaller if possible, because sardines are principally sold to the very poor people. The wholesale price of sardines is 50 Chilean gold pesos, or about $14.50 United States currency, per case of 100 tins of 180 grams each, f. o. b. Talcahuano, with 8 per cent discount. A few tins weighing 470 grams are also sold, but they are too expensive. The foreign brands which are most popular have the preference because they are so well known that the quality and weight is considered guaranteed. American sardines are imported into Chile in large quantities and seem to find a sale on account of their very low price.

To increase the imports of fishery products from the United States it seems advisable to give attention to good quality and to good presentation. Sardines should be well packed, so as to avoid objections now made to them. As the cottonseed oil is reported to congeal and bulge the tins this should be remedied. Nothing seems necessary in the case of salmon, although during the early part of 1920 there was much discussion of competition from Japan and Norway.

The detailed figures for 1919 and 1920 given below show the kinds, quantities, values, ports through which imported, and countries of origin of each fish product. The importations for this district are shown by the figures for its ports, Talcahuano, Coronel, and Valdivia. The Chilean gold pesos in which official statistics and customs duties are given in Chile have been converted at the rate of 36½ cents,

United States currency, to the gold peso, which is the rate declared by the United States Treasury; but the value of the gold peso fluctuates, now being about 29 cents. A great deal of canned fish is sold to the people of the poorer class, who often buy a can of salmon or sardines for lunch or dinner instead of eating a regular meal. The market for imported canned fish has grown considerably in recent years. During the World War the imported article supplanted the domestic canned shellfish produced in the southern provinces, as the tin plate for a can cost as much as selling price of the can of fish. Now, with cheaper tin plate, it is possible that the lower-priced domestic canned shellfish may to some extent take the place of salmon and sardines in this part of Chile.

American salmon is supreme in this market, and all merchants unite in declaring it excellent, of fine quality, and of excellent reputation. Almost all the salmon now comes from the United States, principally from San Francisco, although some formerly came from other countries. There is a large demand for it here. It is necessary for it to be "Red label," and the popular size is the 1-pound tin. The two classes which are principally sold are the "pink" and "chum." Also red salmon is sold, but the price is much higher, and only the rich people can buy it. The wholesale price of salmon is 7 pesos gold, or about $2.03 United States currency, per dozen, with 8 per cent discount, dispatched at Talcahuano. The salmon comes in cases of 4 dozen 1-pound cans.

Canned salmon pays under tariff No. 27 an import duty of 0.25 gold peso per kilo, or $4.14 per 100 pounds gross weight. The import duty was not increased by the recent tariff increase. The importations of salmon have increased considerably during the last few years. The detailed statistics for 1919 and 1920 follow:

Amount and value of canned salmon imported into Chile, 1919 and 1920.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Arica	8,138	$910	12,030	$1,266
Iquique	68,358	6,998	212,766	16,296
Tocopilla	17,349	2,030	31,823	4,289
Antofagasta	62,777	8,418	620,437	66,458
Taltal			21,806	1,993
Chañaral			14,210	1,577
Coquimbo	55,057	6,439	217,120	15,809
Valparaiso	1,269,319	130,526	3,447,504	352,124
Talcahuano	75,542	7,487	413,021	48,348
Coronel			6,776	809
Valdivia			104,149	10,847
Punta Arenas	75,090	7,119	76,309	7,805
Parcel post	22	5	35	9
Total	1,631,652	169,932	5,177,986	527,630
COUNTRIES.				
Argentina	953	253		
Brazil			42,231	7,272
Canada			394,836	34,828
Great Britain	34,109	3,891	8,296	1,046
Italy	17,600	912		
Japan	14,868	2,271	11,220	2,148
Norway			200	33
Peru			20,240	2,188
Sweden			658	365
Spain			482	194
United States	1,564,122	162,605	4,699,823	479,556
Total	1,631,652	169,932	5,177,986	527,630

The second most important fish product is the sardine. The statistics show that American sardines make up a goodly part of the total importations by Chile. Under tariff No. 28 canned sardines pay a duty of 0.30 gold pesos per kilo, or $4.97 per 100 pounds gross weight. The duties were not increased by the recent amendment to the customs tariff. The detailed figures of importations for 1919 and 1920 follow:

Amount and value of canned sardines imported into Chile, 1919 and 1920.

	1919		1920	
	Pounds.	*Value.*	*Pounds.*	*Value.*
PORTS.				
Arica	2,765	$508	22,464	$7,110
Iquique	26,873	5,116	54,740	18,829
Tocopilla	3,729	1,198	7,363	1,684
Antofagasta	51,757	13,257	151,259	49,278
Taltal	2,759	989	4,259	1,132
Chañaral	....	....	233	29
Coquimbo	5,223	1,076	57,581	17,714
Los Andes	20,253	1,717	748	163
Valparaiso	562,553	131,298	1,496,442	325,935
Talcahuano	41,140	9,288	271,102	51,356
Coronel	18,920	4,845	26,600	7,350
Valdivia	....	....	47,474	8,163
Punta Arenas	71,874	17,171	41,400	15,491
Parcel post	48	9	268	146
Total	807,894	186,472	2,181,933	504,380
COUNTRIES.				
Argentina	48,105	12,401	748	163
France	11,092	6,699	122,221	66,778
Germany	....	....	6,076	948
Great Britain	16,900	4,552	84,707	28,516
Italy	2	1	11	5
Japan	1,643	519	....	....
Netherlands	....	....	392	281
Norway	30,996	10,982	378,726	104,408
Peru	4	1	....	....
Portugal	942	330	81,968	20,818
Spain	345,033	94,346	495,246	122,129
Sweden	2,977	877	124,401	21,301
United States	350,200	55,764	887,570	139,030
Total	807,894	186,472	2,182,066	504,380

Canned fish or shellfish of various kinds are imported to a limited extent, the imports through the ports of this district being very small. One of the principal items under this head is caviar. Under tariff No. 14 fish or shellfish, not otherwise specified, pay a duty of 1.20 gold pesos per kilo. or $19.86 per 100 pounds gross weight. Under tariff No. 15 fish roe, known as caviar, pays a duty of 3 gold pesos per kilo, or $49.66 per 100 pounds gross weight. The detailed imports for 1919 and 1920 follow:

Amount and value of canned fish or shellfish imported into Chile, 1919 and 1920.

	1919		1920	
	Pounds.	Value.	Pounds.	Value.
PORTS.				
Arica	108	$43	878	$252
Iquique	12,302	2,412	7,262	2,403
Tocopilla	464	152	1,771	417
Antofagasta	7,207	2,687	46,651	17,047
Taltal	....	....	616	158
Chañaral	275	49	651	181
Coquimbo	1,263	453	117	15
Los Andes	462	394	568	91
Valparaiso	42,713	13,971	110,704	55,010
Talcahuano	1,745	426	10,311	4,497
Coronel	5,777	3,248	765	485
Punta Arenas	23,555	7,402	23,976	9,043
Parcel post	447	145	46	25
Total	96,318	31,382	204,316	[1] 89,624
COUNTRIES.				
Argentina	5,168	1,602	675	135
Canada	....	....	77	13
China	5,432	628	1,379	189
France	3,949	2,417	25,533	19,415
Germany	....	....	354	49
Great Britain	9,176	1,994	23,701	6,892
Italy	2,413	204	12,747	6,528
Japan	3,907	981	6,013	2,671
Netherlands	....	....	2,759	1,047
Norway	1,430	329	26,921	9,107
Portugal	....	....	13	9
Spain	41,906	15,343	47,300	22,889
Sweden	440	146	11,898	5,772
United States	22,497	7,738	44,946	15,273
Total	96,318	31,382	204,316	[1] 89,989

[1] Difference in value of imports by ports and by countries in 1920 is due to an error in official statistics.

Canned lobster finds only a very small market in Chile, and practically none in this district, owing to the abundance of a large crayfish similar to a lobster. Under tariff No. 14 canned lobster pays a duty of 1.20 gold pesos per kilo, or $19.86 per 100 pounds gross weight. The statistics of imports for 1919 and 1920 follow:

Amount and value of canned lobster imported into Chile, 1919 and 1920.

	1919		1920	
	Pounds.	Value.	Pounds.	Value.
PORTS.				
Iquique	55	$21	....	....
Tocopilla	88	49	....	....
Antofagasta	788	591	357	$332
Coquimbo	37	17	24	13
Valparaiso	623	250	1,729	1,192
Talcahuano	....	....	429	350
Punta Arenas	5,328	1,761	4,459	2,842
Total	6,919	2,689	6,998	4,729
COUNTRIES.				
Argentina	891	314	275	146
Spain	75	44	....	....
United Kingdom	125	110	3,144	2,289
United States	5,828	2,221	3,579	2,294
Total	6,919	2,689	6,998	4,729

Dried codfish has a good sale locally. The better grade comes from the United States and is more in demand than the cheaper Japanese

article, although at much higher prices. Some codfish also comes from Scotland and Norway. Codfish under tariff No. 12 pay a duty of 0.30 gold pesos per kilo, or $4.96 per 100 pounds gross weight. The statistics for 1919 and 1920, which follow, show the importations of all kinds of fresh, dried, and salted fish including codfish.

Amount and value of fresh, dried, and salt fish imported into Chile, 1919 and 1920.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Arica			1,441	$387
Iquique	12,661	$2,878	36,714	11,344
Tocopilla	1,802	335		
Antofagasta	42,645	8,751	95,781	36.460
Chañaral			343	29
Coquimbo	6,050	1,357	9,218	1,275
Los Andes	88	8		
Valparaiso	351,371	56,501	681,131	133,509
Talcahuano			59,473	12,250
Coronel			550	79
Valdivia			17,827	3,605
Punta Arenas	53,763	8,457	83,233	17,075
Parcel post	46	7	40	13
Total	468,426	78,294	985,751	216,026
COUNTRIES.				
Argentina	7,328	1,324	1,767	615
Belgium			3,476	427
Bolivia			277	73
Brazil			2,156	793
China	1,709	739	2,141	926
Denmark			5,317	1,288
France			2,310	536
Germany			7,863	7,411
Great Britain	43,523	8,883	91,960	16,153
Japan	262,825	36,721	243,591	28,004
Netherlands			44,719	6,650
Norway	3,186	1,077	300,274	89,126
Spain	9,680	2,726	16,192	3,596
Sweden			96,144	11,801
Switzerland			427	39
United States	137,535	26,360	164,430	48,500
Uruguay	2,640	464	506	88
Total	468,426	78,294	983,550	216,026

Shellfish are imported in very small quantities and pay a duty of 0.30 gold pesos per kilo, or $4.96 per 100 pounds gross weight, under tariff Nos. 12 and 13. The imports for 1919 and 1920 were as follows:

Amount and value of shellfish imported into Chile, 1919 and 1920.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Iquique	21,637	$7,022	70	$39
Antofagasta	55,097	19,482	2,442	1,175
Valparaiso	3,463	1,392	7,812	4,135
R. de Fronteras			198	33
Total	80,197	27,896	10,522	5,382
COUNTRIES.				
China	3,810	1,049	70	39
Japan	1,349	563		
Peru			198	33
United States	75,038	26,284	10,254	5,310
Total	80,197	27,896	10,522	5,382

Sponges are here classed as a fish product. Under tariff No. 51 they pay an import duty of 4.30 gold pesos per pound, or $74.50 per

hundred pounds net weight. The importations during 1919 and 1920 were as follows:

Amount and value of sponges imported into Chile, 1919 and 1920.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Arica	2	$27	4	$4
Iquique	33	179	31	237
Tocopilla	2	1	....	....
Antofagasta	20	137	9	83
Taltal	....	....	4	27
Valparaiso	3,225	10,290	1,230	6,524
Talcahuano	66	330	51	659
Coronel	13	48	....	....
Valdivia	22	7	....	....
Punta Arenas	97	304	37	119
Parcel post	81	598	143	1,122
Total	3,561	[1] 11,921	1,509	8,775
COUNTRIES.				
Argentina	37	186	13	21
Bolivia	....	....	4	33
France	141	1,276	383	3,816
Germany	....	....	18	64
Great Britain	724	3,292	335	2,333
Italy	9	37	35	271
Turkey	....	....	2	7
United States	2,651	7,134	719	2,230
Total	3,562	[1] 11,925	1,509	8,775

[1] The difference in values of imports by ports and by countries in 1919 is due to an error in official statistics.

The spermaceti consumed is principally produced in Chile. Under the provisions of tariff number 50 spermaceti pays a duty of 0.30 gold peso per kilo, or $4.96 per 100 pounds gross weight. The imports for 1919 and 1920 were as follows:

Amount and value of spermaceti imported into Chile, 1919 and 1920.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Arica	26	$12	....	....
Antofagasta	33	12	....	....
Coquimbo	33	14	....	....
Valparaiso	742	149	227	$67
Total	834	187	227	67
COUNTRIES.				
United Kingdom	794	175	156	43
United States	40	12	71	24
Total	834	187	227	67

Crude whalebone is produced in Chile to some extent and is not imported in commercial quantities. Under tariff number 30 it pays a duty of 0.75 gold peso per kilo, or $12.42 per 100 pounds legal weight. The imports for 1919 were 11 pounds, valued at $77. There were no imports in 1920.

The reexport of imported products is not of importance. The reason for the existence of reexportation of such products is simply that some small quantities of fish products which are imported into Chile are reexported to the neighboring countries, such as Bolivia

and Argentina, but this is not a regular business and seems to be largely accidental. Very little of this reexportation is from this district. The following statistics for 1919 and 1920 show the extent of the reexportation.

Imported products reexported from Chile, 1919 and 1920.

CANNED SALMON.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Antofagasta			136	$64
Arica	4,587	$649		
Punta Arenas	2,273	2,479	550	161
R. de Fronteras	1,320	402	66	20
Total	8,180	3,530	752	245
COUNTRIES.				
Argentina	2,273	2,479	550	161
Bolivia	4,587	649	202	84
Peru	1,320	402		
Total	8,180	3,530	752	245

CANNED SARDINES.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Arica	783	$336	330	$102
Antofagasta	524	394	3,155	1,565
Valparaiso			51	13
Punta Arenas	928	518	1,162	419
R. de Fronteras	405	177		
Total	2,640	1,425	4,698	2,099
COUNTRIES.				
Argentina	928	518	1,162	419
Bolivia	1,307	730	3,485	1,667
Ecuador			51	13
Peru	405	177		
Total	2,640	1,425	4,698	2,099

CANNED FISH OR SHELLFISH.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Arica	803	$244		
Antofagasta	2,440	2,371	440	$306
Los Andes	108	18		
Punta Arenas	930	433	715	238
Total	4,281	3,066	1,155	544
COUNTRIES.				
Argentina	1,038	451	715	238
Bolivia	3,243	2,615	440	306
Total	4,281	3,066	1,155	544

FRESH, DRIED, OR SALT FISH.

	1919		1920	
PORTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Antofagasta			741	$362
Los Andes			2,420	411
Valparaiso	4	$7	29	22
Punta Arenas	6,659	2,026	4,759	1,206
Total	6,663	2,033	7,949	2,001
COUNTRIES.				
Argetina	6,659	2,026	7,179	1,617
Bolivia			741	362
Japan	4	7		
United Kingdom			29	22
Total	6,663	2,033	7,949	2,001

PUNTA ARENAS.

[By Austin C. Brady, consul, December 3, 1921.]

The fishery products of this district consist principally of two species of fish, the róbalo and the pejerrey, a crustacean, the centolla, and mussels of several sizes. There are trout in some of the streams, but few trout are taken. Some sea urchins taken along the coasts are used as food. The centolla is the only product of this district that is now prepared for market. Centollas are taken in encircling nets, which are usually allowed to remain in place over night. Róbalos and pejerreyes, both salt-water fish, are also taken in encircling nets, some of which are drag seines.

The centolla, an eight-legged crustacean, resembles an enormous spider, and probably is of the same family as the spider crab. The flesh is similar in taste to that of the lobster but more delicate. Centollas are found at places in the Straits of Magellan and in the protected waters of the Chilean coast, both north and south of the straits. It is reported that similar crustaceans are found in Japanese, South African, and Australian waters.

Centollas are canned in Punta Arenas during the months of November, December, and January. The closed season extends only from June 1 to October 1, but it is stated that usually it is possible to take them in large quantities only during the three months mentioned. There is at present but one establishment at this port engaged in preparing them for market, 50 persons being employed during the canning season. The centollas taken for canning range in weight from 1 to 4½ pounds. They are dumped into iron kettles and boiled, and immediately thereafter the flesh of the body and legs is extracted and placed in cans. The cans are thoroughly steamed after sealing. The local cannery handles from 60,000 to 100,000 centollas yearly. It is estimated that 70,000 will be handled this year and that the output will be about 50,000 cans of one-half kilogram each, or a total of approximately 55,000 pounds. The shells of the centollas are sold by the cannery to local poultry farms.

The Punta Arenas cannery is now marketing its product at the rate of 180 Chilean paper pesos (about $20 at the present exchange value of the American dollar) a case of 48 half-kilogram cans. Almost the entire ouput is shipped to central and northern Chile. Practically no fishery products of this district are at present exported. Occasionally small shipments of canned centolla are made to Argentine Patagonia.

Chilean customs statistics show the following imports of fishery products into this district during the calendar years 1918 and 1919: In 1918, dried and salted fish, 11,288 Chilean gold pesos ($4,120 normal exchange); canned salmon, 20,451 gold pesos ($7,464); canned sardines, 46,914 gold pesos ($17,123); other canned fish, including shellfish, 22,421 gold pesos ($8,183). In 1919, dried and salted fish, 23,170 gold pesos ($8,457); canned lobster, 4,825 gold pesos ($1,761); canned salmon, 19,504 gold pesos ($7,118); canned sardines, 47,043 gold pesos ($17,170); other canned fish, including shellfish, 20,279 gold pesos ($7,401). Statistics showing countries of origin are not available here.

Some supplies for Argentine Patagonia and Argentine Tierra del Fuego are obtained from Punta Arenas, and in 1919 the total value

of imported products reexported to those districts was 2,497,860 gold pesos ($911,718 normal exchange). The following were the reexports of fishery products: Dried and salted fish, 5,552 gold pesos ($2,026 normal exchange); canned salmon, 6,792 gold pesos ($2,479); canned sardines, 1,420 gold pesos ($518); other canned fish, including shellfish, 1,186 gold pesos ($432).

Most of the canned salmon consumed in this district is from the United States. Much dried codfish from the United States was sold here during the years of the war, but due to prevailing exchange conditions none is now being imported. An inferior quality of codfish from Japan now is on sale, and the better grades in the local market are from Norway and Scotland. Sardines are imported from Spain principally, the Spanish sardines being preferred to all others except the French, which cost more and consequently are not sold as extensively. Dealers and exporters' agents explain the preference for the Spanish and French sardines on the ground that they are packed in olive oil. During the period of the war there were imports of American sardines, smoked and in tomato sauce and in oil. In pre-war years some Norwegian sardines exported by German concerns were marketed here, and offers of these sardines are again being made by German exporters, at prices lower than the Spanish products.

Imported fish products are among the food products that have been affected by the business depression prevailing in this district, and the sales at present are limited. Salesmen sent by American exporters to other districts of Chile should visit Punta Arenas; important local concerns are direct importers. American exporters should be prepared to grant to responsible importers the same credit terms obtainable from European houses. Fish products are not subject to customs duty on entering the Territory of Magallanes at Punta Arnas.

VENEZUELA.

MARACAIBO.

[By William A. Hickey, vice consul, October 15, 1921.]

Lake Maracaibo yields a munificent supply of many varieties of fresh and salt water fish, which is consumed by the people of this district. The poorer classes live almost entirely on the fish product of Lake Maracaibo, and many types of fishing craft are daily engaged in supplying the local needs. The principal fishery products of the district are the "corbina," weighing from 3 to 6 pounds and consumed by the poor people without much preparation or cure; the "lisa," weighing about 2 pounds and considered by many to be the best eating fish of the district; the "jurel," weight from 2 to 4 pounds.

The most common method employed by the native fishermen in this vicinity in obtaining the fish product of Lake Maracaibo is by means of large nets. Sailing craft of various types operated by the peons of the district bring the day's catch to market. The fish product of Maracaibo is salted and sun dried before being placed on the market, but the peons consume the lake fish without preparation of any kind. The only fishery product exported from the Maracaibo consular district is the "corbina." This product is shipped by a Chinese concern of Maracaibo to the United States for trans-

shipment to Hongkong, China. The value of this product exported in 1919 was $387.73; in 1920, $398.82.

The following are the imports of fish products into this district with countries of origin and values for 1918, 1919, and the period from January to July, 1920. The statistics for the remaining period of 1920 have not as yet been made available by the Venezuelan Government.

Value of fish products imported into Maracaibo consular district 1918, 1919, and January to July, 1920.

Country of origin.	Sardines.			Salmon, codfish, shrimp, and tuna.		
	1918	1919	January to July, 1920.	1918	1919	January to July, 1920.
United States	$474.51	$17,975.90	$22,619.42	$205.59	$4,808.52	$29,042.34
Spain		6,456.47	51,776.54		187.49	7,872.88
Germany			5,061.30			
Holland			1,920.38			1,369.81
England			491.18			544.68
Italy						194.23
Total	474.51	24,432.37	81,868.82	205.59	4,996.01	39,023.94

Separate statistics for the products are not obtainable, as the Venezuelan Customs combine the classification of all canned fish imported into the country with the exception of sardines. No fish products imported into the Maracaibo consular district are reexported.

A comparison of the above values of imports shows that in 1918 the United States supplied all of the small amount of fish products imported into this district, while in 1919, 74 per cent of the imports of sardines and 97 per cent of all other fish products came from the United States. For the period from January to July, 1920, Spain took the lead in supplying the district with sardines, furnishing 63 per cent of the total amount of this product, as against 28 per cent by the United States.

The opinion of one of the leading wholesale merchants in Maracaibo is expressed relative to the comparative merits of the American and Spanish canned sardines as follows: "While the American canned sardine is much cheaper in value, it does not contain pure olive oil which the Spanish product does, and therefore the American goods do not maintain the reputation of having the preservative qualities of the Spanish products."

It would appear advisable for the American exporter of canned fish products to take into consideration the climatic conditions of the district and its effect on the preservative quality of a product enabling it to withstand the extremes of heat, moisture, and long delays arising from the lack of modern facilities in transporting goods to the interior of Venezuela. In the preparation of canned sardines the opinion has been expressed by several merchants that the American sardine is not prepared in an oil of sufficient properties to remain edible for more than a short period of storage. The constant heat of the Lake Maracaibo region is exceptionally destructive to all goods not properly prepared.

PUERTO CABELLO.

[By Wm. P. Garrety, consul, September 22, 1921.]

The latest statistics of imports into this district are those for the first six months of 1920. The classification given is that of the customs regulations of Venezuela.

Country of origin.	Fish and shellfish.		Sardines.	
	Pounds.	*Value.*	*Pounds.*	*Value.*
United States	164,399	$22,763.19	150,436	$21,303.53
Spain	3,060	1,312.40	120,881	28,951.35
Holland	1,496	492.92	5,335	3,860.00
France	1,522	1,096.82	4,132	3,060.98
Great Britain	6,413	1,252.18	19,897	5,250.95
Italy	396	413.02		
Total	177,286	27,330.53	300,681	62,426.81

From the above statistics it appears that although the quantity of sardines imported from Spain is somewhat less than from the United States the value is considerably greater, indicating that the Spanish article is more highly valued. If the Spanish article is really no better than the American, it might be possible to educate the consumers to a knowledge of this. It is difficult to greatly increase the imports of fishery products, as there is an abundant and excellent supply of fresh fish always available. No fishery products are reexported.

LA GUAIRA.

[By S. J. Fletcher, vice consul, November 8, 1921.]

Fish are abundant along the northern seacoast of Venezuela, and one of the chief industries of the island of Margarita, the islands of the Tortugas, and the coast of the mainland from Cumana to Carupano is the catching and dry-salting of fish. Many of the immediate tributaries of the rivers of the coastal Andes are destitute of fish, and the coastal fisheries find a ready sale for their products throughout the Andes as well as in the interior of the country. Certain small quantities are also exported, mainly to the neighboring islands of Trinidad and Curaçao. Fresh fish of many varieties are consumed in the coastal villages and cities, but for the preparation of salt fish the species most commonly used are the dogfish, sawfish, anchovy, shad, and sardines.

Nets, baited drop lines, and fish traps made of local reeds are used in catching fish. As a rule, fishing is done by groups of men in small boats, often nothing more than Indian dugouts, who watch for the appearance of a shoal of fish and then hastily arrange their nets. Various-sized nets are used, the mesh and size depending upon the size of the fish it is desired to take. The transparent waters of the Caribbean enable the fisherman to see the fish from great distances. The hauls are taken ashore to the houses of the fishermen, where the whole family helps in the cleaning and dry-salting of the catch. There are many small settlements on the northern coast of Venezuela and on the Island of Margarita and the Tortugas devoted entirely to the catching and drying of fish.

As stated above, most of the fish caught in Venezuelan waters are consumed locally or shipped to the interior towns of the Republic. However, there exists a small export of dry salt fish to the neighboring islands, the total for the year ending December 31, 1919, being 224,342 kilos (493,552 pounds), valued at 104,614 bolivars ($20,190.50). Ports of shipment and ports to which the dry fish were consigned were as follows:

From—	To—	Pounds.	Value.
La Guaira	Porto Rico	748	$57.90
Maracaibo	Curacao, Dutch West Indies	150,986	7,537.42
Do	United States	5,493	331.19
Do	Trinidad, British West Indies	26,635	934.70
Do	Canada	1,316	23.16
Puerto Cabello	Bonaire, Dutch West Indies	550	23.16
Do	Curacao, Dutch West Indies	29,722	1,202.78
Rio Caribe	Trinidad, British West Indies	18,920	907.10
Puerto Sucre	do	26,950	1,094.89
La Vela	Curacao, Dutch West Indies	18,740	725.68
Cristobel Colon	Trinidad, British West Indies	118,177	4,350.03
Pampatar	do	88,062	2,712.42

Various kinds of canned, dried, and smoked fish, and sardines are imported into Venezuela from the United States and Europe. For the purpose of statistics and for the assessment of customs duties they fall under two classifications, namely, fish and shellfish, and sardines. The total imports to Venezuela for the year ending December 31, 1919 were: Fish and shellfish, 576,561 pounds, valued at $91,183.04, and sardines, 806,359 pounds, valued at $102,475.47. Through the port of La Guaira importations were made from the following nations:

From—	Fish and shellfish.		Sardines.	
	Pounds.	*Value.*	*Pounds.*	*Value.*
United States	162,965	$19,503.23	230,769	$26,960.17
Spain	30,551	3,377.50	112,523	17,791.51
France	4,215	1,039.69	9,975	2,085.37
Holland	1,349	146.49		
Great Britain	706	112.91		
Italy	1,597	448.15	10,883	2,858.33

It will be noted from the above table that the United States is well in the lead in furnishing canned fish and sardines to the Venezuelan market. The small amount of French, Spanish, and Italian goods found in the market is due more to the enterprise of the merchants of these nationalities than to a lower-priced or better grade of product. The American products can be obtained in almost every retail grocery store, and their supremacy in these markets seems secure.

Naturally, the imported products are consumed in the cities, principally at Caracas, and the interior mountain villages.

BRITISH GUIANA.

GEORGETOWN.

[By Christie W. Davis, consul, September 18, 1921.]

The local fisheries are of small economic importance. A few small vessels, each manned by two or three men, supply Georgetown and New Amsterdam with fresh fish, consisting of snapper, snook, querri-

man, and the like. The smaller fish are caught in seines near the mouths of the rivers and larger fish by hook and line. Among those secured by the latter method the gilbacker is of some importance, its air bladder being used in the reduction of fish glue. Shrimp are obtained along the seacoast by nets dragged by hand. On the upper portion of the rivers many fish are caught by weirs erected across the mouths of small creeks. A gate is dropped across the opening at high tide, thus preventing the escape of the fish. A few fish are cured for private use, but cured local fish are not on sale. No fish are exported.

Cured fish is one of the most prominent items among the provisions imported into the Colony and is second only to flour in value. It is of interest to note that salt fish has always been imported in comparatively large quantities. Formerly such imports consisted largely of salt herrings for the slaves, but cod and scale are now more important. In the days of the old "trading factories" ship's rations were issued. Later similar rations were issued to the slaves on the plantations to supplement the local vegetables. Codfish and plantain still remain a staple food among the negroes, although the high price of the plantain has rendered it somewhat of a luxury, and the usual meal now consists of rice boiled with a small quantity of salt fish.

Figures showing the values of imports of fish and the countries of origin during 1920 are not yet available. The following are the only figures for imports yet published for that year:

	Quantity.		Quantity.
Cod ....cwt..	3,238	Herring, smoked ....lbs..	99,221
Scale ....do....	31,674	Mackerel, pickled ....bbls..	3,617
Herring, pickled ....bbls..	3,135	Salmon, tinned ....cases..	14,800

More detailed figures are available for the years 1919 and preceding years. Figures for 1913 and 1919 follow:

Amount and value of fish imported into British Guiana, 1913 and 1919.

TINNED, CANNED, OR PRESERVED IN JARS OR BOTTLES.

Country of origin.	1913		1919	
	Pounds.	*Value.*	*Pounds.*	*Value.*
United States	112,710	$14,709	188,719	$47,726
United Kingdom	151,497	16,707	30,893	7,780
Canada	9,806	1,531	70,257	15,806
British West Indies	....	....	7,203	1,668
Portugal	55,054	8,359	....	....
Other countries	13,297	650	3,222	1,270
Total	342,364	41,956	300,294	74,250

SMOKED AND DRIED.

Country of origin.	1913 Pounds.	1913 Value.	1919 Pounds.	1919 Value.
United States	309,792	$21,930	435,456	$54,258
United Kingdom	3,518,928	153,801	....	....
Canada	1,384,544	68,103	2,738,848	322,452
Other countries	17,248	859	174,048	17,035
Total	5,230,512	244,693	3,348,352	393,745

Amount and value of fish imported into British Guiana, 1913 and 1919—Continued.

MACKEREL AND SALMON, PICKLED.

Country of origin.	1913		1919	
	Barrels.	*Value.*	*Barrels.*	*Value.*
United States	39	$512	99	$2,524
United Kingdom	191	1,276		
Canada	846	9,929	2,259	55,472
British West Indies	69	794	97	2,287
Other countries	90	1,052		
Total	1,235	13,563	2,455	60,283

ALL OTHER KINDS, UNENUMERATED.

United States	4	$48	19	$140
United Kingdom	80	419		
Canada	2,518	6,579	3,321	33,713
British West Indies	12	51	393	5,315
Other countries	6	46		
Total	2,620	7,143	3,733	39,168

RECAPITULATION SHOWING TOTAL VALUE OF ALL KINDS.

United States		$37,199		$104,648
United Kingdom		172,303		7,780
Canada		86,142		426,443
Other countries		10,717		27,515
Grand total		306,361		566,386

There is a small reexport of fish, mostly to Dutch Guiana. In 1919 these exports were valued at $10,645. The reason for such trade is that steamship communication is better and more frequent from North America to Georgetown than to Paramaribo.

It will be noted that Canada has a preponderance of the trade in fish products. Granting that quality is equal, price is the governing factor in the placing of local orders. The present high rate of American exchange and the preferential duty accorded to goods produced in the British Empire afford a considerable advantage to Canadian fish. Because of these adverse factors it is not advised that any steps be taken at this time to increase the trade from the United States. American firms are well represented in the local market and would undoubtedly secure a larger share of the business were it not for the exchange and preferential duty.

BRAZIL.

PARA.

[By Geo. H. Pickerell, consul, December 31, 1921.]

The principal local fishery products are dried-smoked and dried-salted fish. The methods of capture are of the simplest nature—hook and line or spear—none of the modern improvements being employed. In fact, capital is so lacking and conditions are so peculiar to this region that it is doubtful whether up-to-date measures if employed would find a remunerative return.

As to method of cure, there is none of a scientific nature. The usual way is to cut up or open the fish, according to its size and

quality, hang the flesh on racks, and allow it to dry. If it is desired, they simply add the salt. Dried-smoked is prepared by covering the fish with the fine leaves and foliage of the goiabada tree or other aromatic plant, which, when it catches fire, creates an intense smoke and some heat, about sufficient to cause the fat to drip, which in turn keeps the fires going. When sufficiently smoked, the fish are packed in lots and sent to market.

Within the last two years the Government of Brazil has undertaken to develop the fisheries and has called in foreign advisors to study and report upon their possibilities. The Government also maintains a special steamer that visits the different fishing colonies and is doing much to consolidate these and make them effective as food producers.

There is little or no foreign exportation of fish products, but within the last two years considerable quantities of fish have been exported to Maranham, Ceara, Pernambuco, and other States to the south. No statistics are available to show the amount of this exportation, but it is increasing monthly and is reported to be affecting the importation of codfish from the United States and Canada. This market is a small importer of American codfish and salmon, but at the present time is importing nothing on account of adverse exchange and the fact that it is well supplied locally with fish almost as good. Sardines are imported from Portugal and France, but the former country supplies by far the most. There are no reexports of imported fish.

As to preference, the largest colony (foreign) in this district is the Portuguese, and they are very patriotic, insisting upon having as many as possible of the products of their own country. Canned salmon and cod they expect from the United States, and as both are luxuries the amount consumed does not figure heavily in their sustenance account. French sardines are well and favorably known to the British colony, which is probably their largest consumer. This preference is not a matter of advertising or superior selling ability or price, but a preference based upon a liking created years before the consumer reached Brazil.

Fish that is not sufficiently cured to withstand the tropical climate should not be shipped, as it only means loss to the importer and no doubt to the exporter as well. The best advertising that can be devised for this industry is the sending of good fish, for the people like codfish, especially the Portuguese. Following is a statement showing receipts of fish prepared at this port for the years 1917 to 1921. The weights are in metric tons:

Product.	1917	1918	1919	1920	1921
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Pirarúca	2,205	1,551	1,793	1,643	1,245
Other salted fish	244	399	491	409	1,140
Total	2,449	1,950	2,284	2,052	2,385

PERNAMBUCO.

[By C. R. Cameron, consul, September 27, 1921.]

The fishery products of this district consist almost exclusively of fresh sea foods, such as salt-water fish, mostly, and in a lesser degree

fresh-water fish, shrimp, lobsters, oysters, etc. Whales sometimes appear in these waters, and the latest available statistics show that the State of Parahyba, which is the only State in this district, so far as known, having a whale-fishing industry, exported 248 tons of whale oil, worth $31,483.20, United States currency, on the basis of $0.23 United States for 1$ Brazilian currency, the official rate of exchange for 1916. Locally produced salted fish are sold in small quantities in some of the interior markets. The fish are taken mostly by line fishing off the coast, with some seine fishing on the beach. Some gill nets are used in the rivers. There are also a certain number of fishponds maintained along the coast. As stated, almost none of the sea foods of this district are preserved. The few fish that are preserved are cleaned, salted, and dried in the sun. With the exception of whale oil, no fishery products are exported from this consular district. Dried codfish is the principal fishery product imported into this district. Imports for 1919 and 1920 were as follows: 1919, 20,011,154 pounds, valued at $3,940,193; 1920, 23,617,879 pounds, valued at $3,304,490.

The above sums in American currency are converted from Brazilian currency at the official rates of exchange adopted for 1919 and 1920, namely, 26 cents for 1$ and 22 cents for 1$, respectively. The exact figures for imports into this consular district from the various countries are not available, but about half of the codfish comes from Terra Nova, Newfoundland, and the remainder from other parts of Canada and the United States. Salmon and sardines are also imported, most of the salmon coming from the United States and the sardines from Portugal. No fishery products imported into the district are reexported. The United States sells a certain amount of codfish here, having supplied during 1919 more than one-sixth of the total amount imported into Brazil. The following table shows the total importation and the importation from the United States into all Brazil for the past five years:

	1916	1917	1918	1919	1920
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Total importations	52,537,823	45,346,417	47,976,505	39,409,430	65,119,475
Importations from United States	4,426,837	3,816,163	1,645,632	5,105,854	12,394,261

It will thus be seen that there has been a steady increase in the proportion of the importations from the United States. During the same period the proportion of importations from Newfoundland has steadily gone down. There does not appear to be any decided preference for Newfoundland codfish, and the whole matter seems to be one of price, prompt delivery, and custom. There are a number of English commission merchants here who make codfish a specialty, and their connections are with Canadian and Newfoundland exporters. If the American exporters would place an active agent in Pernambuco, there is no doubt but that they would be able to increase their business here.

Regarding other fish products, such as sardines, which are consumed to a very slight extent in Pernambuco, the market is largely supplied from Portugal as a matter of habit. Brazil having been

colonized by Portuguese, its inhabitants are accustomed to Portuguese food products. In fact, many of the owners of grocery stores are of Portuguese nationality and naturally preserve their Portuguese connections as far as possible.

BAHIA.

[By Thos. H. Bevan, consul, September 9, 1921.]

The city of Bahia is situated on a peninsula, with the Atlantic Ocean on one side and the Bay of Bahia on the other. Notwithstanding its ideal location as a base for fishermen, there is not a single trawler operating out of the port. The city is therefore dependent for its fish supply on a small number of native fishermen who can put to sea only under most favorable weather conditions. The two fishes principally caught are the red snapper and a species of mackerel. The supply is very small, and only the wealthy classes can afford to buy fresh fish.

Codfish is imported from St. Johns, Newfoundland, in large quantities, ranking first in importance among Bahia's imports. The entire Canadian supply of codfish is shipped to Bahia during the off-fishing season in small three-masted fishing schooners. These schooners average about 300 net tons and carry about 350 tons dead weight. Their average voyage from St. Johns to Bahia is around 35 days. There is apparently no reason why the American fish merchants can not enter this trade and deliver the codfish here as cheaply, if not cheaper, than the present suppliers. The Americans would have a shorter haul by several hundred miles.

Prior to 1920, when the value of the dollar was quoted around Rs. 3$500, the bulk of the imports of canned fish came from the United States. As the dollar appreciated in value the local importers turned to other markets and are now purchasing their supplies of canned sardines, salmon, lobster, etc., from Scandinavian countries, England, France, and Portugal. As soon as the dollar approximates its normal rate of exchange the business will undoubtedly come back to the United States, as European canners can not successfully compete with the American canners for the South American trade under normal conditions.

There is an excellent demand for codfish in Bahia and the surrounding country. For the past five years the value of the codfish imported here has been greater than that of any other commodity. The official customhouse statistics show the values (United States currency) and quantities imported during the past three years, as follows:

Year.	Pounds.	Value.
1918	15,426,422	$2,160,303
1919	11,673,818	2,177,427
1920	15,755,298	2,500,000

About 95 per cent of the codfish sold on this market is imported from St. Johns, Newfoundland, the remainder coming from the United States and Scandinavia. The shipments from St. Johns are

invariably made by fishing schooners during the offseason. During 1920 there were 18 shipments made in schooners carrying an average of 325 tons of codfish each. It is shipped in barrels of 142 pounds (65 kilos) and half-barrels of 72 pounds ($32\frac{1}{2}$ kilos). The shipments from Europe are made in boxes of about 60 pounds each.

Codfish is one of the principal articles of food in this part of Brazil and is shipped in large quantities into the interior of the States of Bahia, Sergipe, and Piauhy by mule pack trains, two half-barrels making a full load for one animal. It is for this reason that such a large proportion is imported in half-barrels. The 1920 imports amounted to 58,507 barrels, 102,067 half-barrels, and 1,423 boxes.

On account of the long haul from Canada to Brazil on sailing vessels, it frequently deteriorates in value on the voyage, causing the Bahia price to fluctuate according to quality. The best quality sells wholesale in Bahia for about Rs. 110$000 per barrel, and retails around Rs. 2$500 per kilo.

The Brazilian tariff provides for a duty on codfish of 50 reis per kilo, less an arbitrary tare of 10 per cent in weight deducted when packed in either barrels or boxes. As 55 per cent of the duty is collected in Brazilian gold (about 4 paper milreis to the gold milreis) and 45 per cent in paper currency, the actual duty amounts to considerably more than the ostensible rate quoted in the tariff. There are in addition to the duty a number of subsidiary charges that can not be avoided in connection with the dispatch of the goods.

RIO DE JANEIRO.

[By A. Gaulin, consul general, October 5, 1921.]

The principal fishery products in this district are herring, sharks, rays, mullets, drums, bluefish, seriolas (amberfish), groupers, bonito, snapper, roballo, Spanish mackerel, sardines, flounders, bass, shad, oysters, and crabs. The methods employed by the Brazilian fishermen for capturing fish are somewhat antiquated and are limited to the use of rods, hand lines, baskets, and nets of various kinds.

Fish for local consumption are generally transferred immediately from the fishing boats to the market and are not cured. Whenever the market becomes overstocked they are simply preserved in ice. Fish for export and consumption in the interior of the country are usually sundried and crudely salted.

The fisheries of Brazil are under the supervision of the navy department, which is organizing a special service to fishermen in order to encourage this industry. A law that greatly affected the local Portuguese colony was recently passed. It excluded all but Brazilian citizens from the domestic fisheries. Fishery products are only exported to a small extent, and statistics of these exports are classified as follows:

Products exported.	1919	1920
	Pounds.	*Pounds.*
Oysters	143,299	149,913
Dried and preserved fish	284,393	244,711

Of all fish products dried cod is imported in largest quantities at an average rate of 4$758 per dollar. The official statistics of these imports in 1920 are given below.

Country of origin.	Pounds.	Milreis.	Dollars.	Country of origin.	Pounds.	Milreis.	Dollars.
United States..	12,394,261	8,493:935$	$1,746,193	Newfoundland.	32,760,356	20,303:973$	$4,267,333
Great Britain..	3,267,217	2,725:886$	572,905	Unclassified....	773,815	450:669$	133,740
Norway........	7,508,868	6,463:779$	1,358,295				
Canada........	8,414,958	5,788:653$	1,216,806	Total....	65,119,475	44,226:895$	9,295,272

Canned fish, such as salmon and sardines, are imported in considerable quantities, but these products are not separately classified in the customs returns, being included with preserved fish and extracts unenumerated. No preference is given to any one country in the importation of these products. The main consideration in the purchase of dried cod is the price. During normal times the United States competed favorably with other countries in this trade. A large variety of canned sardines has been imported in the last few years. Importations from the United States, France, Norway, and Portugal have been irregularly made. Canned salmon was formerly imported from the United States in moderate quantities. French sardines are predominant on the market at the present time. The exclusion of the American products from the Brazilian market to-day is due to the existing unfavorable exchange situation. An advertising campaign by an American concern established in this district would materially assist in increasing sales. Sardines are canned by a firm in this city. There are also two small canning factories in the State of Rio de Janeiro, one at Itacurussa and the other at Ilha Grande.

Following is a report prepared by Dr. George Wilton Field for the American consulate general at Rio de Janeiro, Brazil:

The most conspicuous event in the fisheries is the awakening to the prejudicial effects of the importation of fish to the neglect of local resources. This importation, with attendant loss by spoilage and unnecessary expense in oceanic transportation which could find more profitable use, is of great economic disadvantage to Brazil.

The jurisdiction of the fisheries has been transferred from the Ministry of Agriculture to the Ministry of Marine, for the reason that the navy could organize the fishermen as a coast defense and better provide for the enforcement of the laws and for the organization of the fishermen into colonies under the direct supervision of the navy. Thus it would be practicable to insure for them more sanitary living conditions, an organized local government, better primary educational facilities, the necessary capital for improved fishing gear, and special instruction in the methods of capturing fish and preparing the product for market.

To this service the auxiliary cruiser *Jose Bonifacio* (formerly the Astor yacht *Nourmabal*) was assigned, in charge of Capt. Frederico Villar, who proceeded to enforce the law vigorously in the States of Maranhao, Para, and Rio de Janeiro. It is probable that this work, carried out with sympathetic justice and wisdom, will do much for the improvement of the deplorable conditions which were found by this "Commission on Fisheries and Sanitation of the Coast," in the recent exploration of the vast, remote, and barren coastal regions between Belem (Para) and Recife (Pernambuco), where the main support of the inhabitants is the still unutilized wealth of marine life. In spite of the abundance of fish suitable for marketing (fresh, salted, or smoked), the monthly catch per man, fishing with hand lines from a jangada (a raft provided with a cotton drill sprit sail and a centerboard) rarely exceeds 1,000 pounds gross weight of the fresh fish. The sun dried and poorly salted product is sold to middlemen in barter or cash and transported on mule back to the hinterland.

Near the large coast cities fairly prosperous fisheries exist, but even here the still relatively small catch per man, the crude methods of handling, and the inefficient

means of transportation and distribution so enhance the cost as to make fish a luxury rather than, as it may well be here, a staple food sold in such a manner and at a price that would replace meat to a considerable degree, and thus be of a greater economic value to the nation.

Brazil is far behind other nations in the big problems of the fisheries, videlicet, how best to secure cheap and efficient means of capture and distribution of marketable fish, which will provide a regular and perpetual supply and be a continuously well-paid remuneration with freedom from undue exploitation to the fishermen; to the consumer a fair market price for both fresh and conserved fish sold under the best sanitary precautions; and a just and reasonably secure return on the necessary capital and labor required for economical development and maintenance of such a system of distribution as the climatic and local conditions require.

Just as North America was developed by European colonists and foreign capital, so to-day the same capital, augmented in the development of North America, is seeking new fields of beneficence in Asia, Africa, and South America. Just as in North America the slogan of "America for the Americans" had short vogue and has given way to the broader and wiser policy of accepting and assimilating every capable right-minded person and well-intentioned capitalist, whose object was to take part in the wise development and conservation of the natural resources of the country for the ultimate benefit of the nation and of a world-wide human interest, so it is to be anticipated that the slogan of "Brazil is for the Brazilians," now so conspicuously placed before the fishermen, will ultimately make for growth of Brazil by demonstrating its futility as a basis for national prosperity and progress * * * if Brazil is to attain and maintain her place among the great nations of the world in the great readjustments and developments into which we are now entering.

Competent authorities agree that Brazil has a remarkable abundance of edible fish in the cool waters of her coast and in the vastness of her rivers, which merely wait wise utilization to become a great and permanent factor in her national wealth, freeing her from a part or the whole of the burden of importing between fifteen and twenty millions of dollars' worth of fish annually from other countries.

It is probable that the Government will in the near future assure conditions which will make possible the employment of increased local and foreign capital—in securing cheaper methods of capture and distribution of fish—in the development of this great national asset. At present the normal average low retail price to the consumer in Rio de Janeiro is about $2\frac{1}{2}$ cents per pound for herring, ranging upward through sharks, rays, mullet, drum, bass, bluefish, seriola (amberfish), groupers, bonito, snappers, to robalo and Spanish mackerel at 50 cents per pound.

The use of the type of fish traps commonly known in the United States as a "pound trap" with one or more leaders is prohibited. The size of mesh used in seines is regulated. The fishermen must be either native born or naturalized Brazilians. The wisdom and even the constitutionality of these laws is being questioned.

Following are extracts on fisheries from "Annual Report on Commerce and Industries for 1919," Rio de Janeiro, Brazil, November 10, 1920:

In 1919 the Ministry of Marine equipped the auxiliary cruiser *Jose Bonifacio* for a trip along the coast to study the conditions of the industry with a view to introducing more modern methods.

During the war the Amazon River developed the piracurú fishery serving as substitute for codfish, which it had been difficult to import from abroad. The fishing industry in the Amazon River, at least for export purposes to other places, is confined to salting and drying this one fish, the piracurú. Other varieties are only locally consumed.

Only one important firm, located in Acarahú, Ceara, is engaged to a limited extent in salting and preserving fish. However, due to its being unable to secure material for canning fish, it has suspended operations temporarily. Various fish-canning factories were established in Rio Grande do Sul, and salted fish is now selling in bales, cases, and barrels. Rio de Janeiro is manifesting a certain amount of interest in the preservation of fish, and while no great developments can be predicted at least two concerns are ordering machinery for canning fish.

The Federal Government requires that all fishermen, as well as their boats, should be registered. * * * A project is contemplated to form a cooperative colony of Brazilian fishermen who are duly registered with the local authorities in places where at least 40 people earn their living by fishing. The object is to erect a school of fisheries for the members and their children, shipyards for naval construction and repairs, and

factories for the manufacturing of nets and fishing tackle. It is also planned to establish stations for fish cultivation on islands given by the Federal Government for this purpose, or on lakes given by the state government, and to institute a cooperative credit system for fishermen.

SAO PAULO.

[By E. M. Lawton, consul, September 9, 1921.]

The State of Sao Paulo borders on the Atlantic Ocean, and the capital city is less than 40 miles from Santos, the principal seaport of Brazil, commercially speaking, the two cities being connected by numerous daily trains and by automobile roads. Santos has a wonderful beach, and the fisheries there supply Sao Paulo city with all the fresh fish needed.

The consulate at Santos is a separate office from Sao Paulo. It is sufficient to explain that the fishermen there are usually uneducated men who live very humbly near the beach and have only such knowledge of fishing as they have learned from infancy. The common practice is net fishing, especially during the months of May, June, and July, the nets being laid by small boats and drawn in by hand from the shore. There is also a certain amount of hand fishing from boats and by nets when the fish are not running inshore. The fishermen also have a practice of building traps of wood, so arranged that the fish enter the traps but can not get out, and are taken with nets from the inclosed sections.

Owing to the nearness of the market (Sao Paulo) the greater part of the fish are sold without preparing them in any way. For the interior sections of the State they are usually salted or smoked. The methods in curing the fish are very primitive and consist simply in cleaning the fish, splitting them open transversely on each side, and rubbing in plenty of salt, or in drying them over wood smoke, according to the taste of the consumer, Fish eggs are also salted or smoked and are sold separately, as they are considered an especially nice delicacy.

The fishing industry in Brazil is not yet very much developed, and no publications seem to be available to explain scientific methods or give information on the art. The few fishing companies which have been organized along the coast are to be found only in the most important ports, and even when organized continue to conduct the operation on the plan and by the methods in vogue from primitive times. There is therefore no complete information about the quantity of fish marketed here, but in general it is more than sufficient for this city of more than 500,000 inhabitants.

There are no exports of fish from Sao Paulo, with the exception of a small amount of oysters which go to Argentina. A considerable quantity of whale oil is brought to Sao Paulo from the north of Brazil. Fish oil, in general, is produced all along the coast of Brazil and, especially in this district, is used for treating leather. On the other hand, codfish and preserved fish are brought from the United States, Norway, Portugal, Spain, and Italy and a small quantity from Japan. None of these products is reexported in any form, but they are entirely consumed locally.

For the year 1920, 3,841 long tons of codfish were imported into this consular district, of which the United States supplied 1,905 tons, Norway 983 tons, and Canada 733 tons. For the same period 28,435

pounds of tinned fish were imported, over 50 per cent of which was divided equally among Portuguese, Italian, and Spanish imports, the United States supplying about 768 pounds. Sardines from Portugal and Spain are the most appreciated in this market and, together with Italy, that preference is easily explained because of the predominant influence of those countries among the people of Sao Paulo. North American salmon is also extremely appreciated but is very little sold because of the excessive price. The reason that salmon and sardines from the United States are not sold in greater quantities can be summed up in one word—price. If American companies were to combine on having a warehouse in this city and send down in sufficient quantities to cut the cost down to the lowest margin the goods would unquestionably sell well, because American canned salmon is considered a very fine dish, and its appearance on one's table is considered an indication of real extravagance, which it certainly is in the light of the present comparative rate of Brazilian milreis in terms of American dollars.

SANTOS.

[By Herndon W. Goforth, vice consul, April 25, 1922.]

Various kinds of fresh fish, oysters, mussels, shrimp, and turtles are found in the rivers, estuaries, bays, and ocean about the port of Santos. These fish products are said to be plentiful, but recent legislation by the Federal Government has made it compulsory for all fisherman to take out licenses before being permitted to engage in fishing. This has driven all independent fishermen from the fields, has practically killed shipments to the city of Sao Paulo, and has made fresh fish a luxury hard to get at any price in the local markets.

Fish are caught in drag nets of from 1 to 2 inch mesh, shrimp in nets of one-half inch mesh, and oysters and mussels are taken with hooks, grapples, etc., wielded by hand. Only a very limited portion of the catch is cured, and such curing as is done is chiefly by drying in the sun. The entire catch is at present easily disposed of at as high prices as fresh fish, but a company recently has been formed at Santos for exploiting the fishing industry and establishing a curing and canning plant.

There is no exportation of fishery products from Santos, although considerable quantities of fresh fish formerly were sent to Sao Paulo, the capital of this State. These shipments have fallen off greatly since the fiscalization of the fishing industry, which resulted in the requirement that fishermen be duly organized and pay heavy license fees.

The following figures, published by the State government of Sao Paulo, show the total importation of fish and fish products through the port of Santos during the years 1919 and 1920. It should be remarked that only about 5 per cent of the quantities represented by these figures were consumed in Santos, the remaining 95 per cent having been shipped by rail to the city of Sao Paulo and there consumed or distributed to other cities.

	1919		1920	
	Pounds.	Value.	Pounds.	Value.
Dried cod:				
Argentina			24,651	$3,767
Canada	1,245,592	$240,239	1,614,677	258,222
United States	1,520,536	310,419	4,191,942	574,972
Great Britian	6,387	1,244	136,329	25,306
Norway	161,480	38,062	2,163,896	398,972
Sweden			286,079	31,157
Newfoundland			33,315	7,508
Uruguay				865
Total	2,933,995	589,964	8,450,889	1,300,769
Unclassified canned and preserved fish:				
Germany			2,387	204
Canada	8,826	2,535		
United States	284,324	115,004	277,097	97,512
France	12,250	9,061	57,387	34,768
Breat Britian	73,990	15,648	286,667	50,750
Spain	262,766	49,610	444,864	101,398
Holland	16,614	2,011	32,960	4,079
Italy	101	165	37,431	11,029
Japan			106	55
Norway	2,732	962	319,037	63,416
Portugual	643,164	230,067	1,034,090	189,133
Total	1,304,767	425,063	2,492,026	552,344

NOTE.—The average value of the Brazilian paper milreis was $0.2621, United States currency, for the year 1919 and $0.2104 for the year 1920.

The value in United States currency of the entire importation of codfish during 1920 was therefore $1,300,769, of which 44.2 per cent, or codfish to the value of $574,972, was imported from the United States as compared with a total importation valued at $589,964 for 1919, of which the United States furnished 52.6 per cent, valued at $310,419. The value of the entire importation of unclassified canned and preserved fish (kippered, salt, and smoked herring, lobster, salmon, sardines, and shrimp) during 1920 was $552,344, of which the United States furnished 17.7 per cent, valued at $97,512, as compared with a total of $425,063 for the year 1919, including imports valued at $115,004, or 27 per cent of the whole, from the United States.

A heavy decrease in the total importation of both codfish and unclassified fish products is recorded for the year 1921. The milreis value of the dried codfish imported during 1921 is stated as 4,493:502$ against 6,182:363$ for 1920. The decrease in dollar value is far greater, since the milreis declined to an average value of about $0.13 for 1921 as compared with $0.2104 for 1920. The United States suffered a heavier proportional loss in this trade than did certain other countries, chiefly because of the high rate of exchange.

Santos is the port of the State of Sao Paulo, and of certain parts of the adjoining States of southeastern Brazil. The local consumption of fish products probably does not exceed 5 per cent of the total quantities imported, most of which enter Santos in transit to the city of Sao Paulo. There is no reexportation of fish products to other countires, however, and the entire quantity imported is consumed in this section of Brazil.

Portuguese fishery products are preferred locally because of the fact that more than 30 per cent of the inhabitants of Santos are Portuguese and about 50 per cent Brazilians with close affiliations with the former mother country. The local trade is also in the hands of the Portuguese and Brazilians, who naturally prefer to

handle the products of the country with whose language and customs they are familiar. Furthermore, lower prices not infrequently are quoted on Portuguese fishery products than on competitive goods from other countries. Local dealers also make the complaint that American canned goods do not withstand the Santos climate, in that the tins rust badly, which greatly injures the sale of the goods and often causes complete loss.

The high rate of exchange made impossible the profitable importation of fishery products from the United States during the year 1921. The Brazilian paper milreis, which has a normal average value of about 25 cents, declined to an average value of about 13 cents for the year 1921, and is now being quoted at 14 cents. American dried codfish is, however, still imported to a limited extent, and also a small quantity of canned salmon, but practically all other American fishery products have been driven temporarily from this market. This trade probably can not be regained until the milreis is again quoted at a rate approximating its normal average value. The use of a rust-resisting container by American packers would also be instrumental in reestablishing and retaining the market for American canned fish.

Codfish packed in earthenware containers enjoys a discount of 40 per cent from the duties; when packed in barrels, a discount of 30 per cent. Unclassified fish enjoys a discount of 10 per cent in duties when packed in casks, tubs, or cases. Exporters should secure exact information as to duties from the nearest Brazilian consulate in the United States and carefully follow the instructions of the local importer as to manner of packing.

PORTO ALEGRE.

[By Samuel T. Lee, consul, September 14, 1921.]

The local fishery products in the Porto Alegre Consular District are the various kinds of subtropical salt-water fish taken chiefly at Rio Grande (do Sul), as well as a few shrimp and occasionally a few low-grade oysters from Santa Catharina. Small seines are used chiefly, and the amount of fish taken supplies the markets of the larger port cities of the district. When there is an abundant catch, some are salted and dried and a smaller amount canned. The entire product is consumed locally, and fish has never figured as an article of export from this consular district. The industry is carried on in a most primitive manner and on a small scale.

Codfish is the only sort of salt fish imported into this market. It comes from Norway, through England, is not boneless, and is packed in boxes of 30 and 60 kilos, or 66 and 132 pounds. A number of provision dealers import Norwegian codfish occasionally from England, but one firm deals exclusively in codfish and distributes it to the various markets of Brazil. They are large importers and occasionally receive cargoes running from 20,000 to 30,000 boxes.

Herring and anchovies are the leading kinds of pickled fish imported into this market. The herring come chiefly from Holland and are packed in tins of 1 dozen and of 50. Anchovies come from Holland and Spain and are packed in tins holding 50 fish. The trade in pickled and smoked fish is limited, and these lines are con-

sidered specialties rather than staples. Occasionally some of the dealers import small consignments of pickled fish and smoked fish, but the trade in these specialties is chiefly in the hands of two firms in Porto Alegre.

Pound bricks of fish packed in 40-pound boxes are unknown in this market. The trade in imported fish is rather limited, because the supply of fresh fish is good and quite abundant for local demand. There is, however, an active movement in Norwegian codfish shipped through England. No official statistics segregated for this consular district are available, and on account of considerable transhipment of freight at Rio de Janeiro it has not been possible to obtain an estimate of the approximate quantity of preserved fish imported into this district.

PARAGUAY.

ASUNCION.

[By Harry Campbell, consul, October 26, 1921.]

Since Paraguay is located approximately 1,000 miles from the ocean, local fishing is limited to the large rivers, the Paraguay and the Parana, and their many smaller tributaries. Although fish in these streams are quite plentiful and are used extensively as food for the inhabitants of the country, there are no statistics available of the total production or consumption, with the exception of the quantities sold in the central market of Asuncion, amounting to 156,860 pounds for the six-months period January 1 to June 30, 1921. These are for the most part fresh fish, and little effort is made locally to cure or prepare the native fish for sale or export.

The fish imported are largely canned salmon and sardines, the 1920 imports of the latter, with the quantities in kilos and pounds, and the values in Argentine gold pesos, being as follows:

Country of origin.	Kilos.	Pounds.	Pesos.	Country of origin.	Kilos.	Pounds.	Pesos.
United States	4,434	9,755	1,144	England	1,050	2,310	262
France	4,190	9,218	1,047	Others	1,565	3,443	393
Portugal	2,341	5,150	585				
Argentina	7,893	17,365	1,978	Total	60,004	132,009	15,123
Spain	38,531	84,768	9,714				

The Government statistics do not indicate the imports of salmon and other canned fish except as they may be included in a miscellaneous item covering canned fish, as well as vegetables, which amounted in 1920 to 40,823 kilos (89,811 pounds), valued at 12,284 Argentine gold pesos. It is not possible to state what proportion of this amount is fish products, but probably less than half, since the figures for sardines are not included therein.

Although the imports of sardines from the United States are small compared with the other countries mentioned, such a proportion would not be shown in the importation of salmon, of which it is estimated that considerably more than 50 per cent is of North American origin. The American salmon is preferred to the European brands, although the latter, owing to lower prices, are able to compete at the present time in that part of the trade that demands low prices re-

gardless of the quality of the product. There is absolutely no prejudice in this country against American salmon and with prices equivalent, it should compete very favorable with the European product. The exchange rate for the dollar has been unfavorable for the past few months for the sale of all kinds of American goods, but this has been improved of late in an encouraging manner. All foreign business in Paraguay is done in Argentine gold peso, the Paraguayan currency consisting only of nonconvertible paper.

URUGUAY.

MONTEVIDEO.

[By Sherwood H. Avery, vice consul, September 27, 1921.]

The following information has been furnished this office by J. N. Wisner, former director of the Instituto de Pesca (Bureau of Fisheries) of the Uruguayan Government, now in business at Buenos Aires, Argentina:

The fishery products in Uruguay are confined almost exclusively to fresh fish. Practically all fish are taken, at least the larger part, by line fishermen. Some are caught in gill nets and a very few with seines. At times a little trawling is done by the Government-owned trawler. Practically all fish are consumed fresh. Some few are salted, and fewer still are smoked and sold as delicacies.

A lot of fishery products are imported by Uruguay in tins and also a considerable quantity of dried fish. Most comes from European markets. At times some cod fish is imported from the United States. Practically speaking, there is no reexport of imported fish products. At the present moment the question of exchange precludes importations from the United States. In ordinary times the retail and wholesale merchants are Spaniards, Italians, etc., and it is only natural that they should import what is produced by their friends or relatives or fellow countrymen and to which the clients feel friendly. Price, quality, and products that appeal to the local appetite are the essential factors in increasing the imports from the United States. Canned salmon is about the only fishery product which might be looked upon as strictly American, but a few canned oysters are, of course, sold. The market for either canned salmon or oysters is negligible.

The following tables, taken from official statistics, show the amounts of fish exported from Uruguay during recent years. Quantities of fresh fish are given in "colleras" (bunches of 3, 4, or 5 fish, according to size), dried and canned fish are given in kilograms, and the official valuations of all are expressed in pesos ($1.034).

Amount of fish exported by Uruguay, 1917 to 1921.

Year and product exported.	Quantity.	Pesos.	Year and product exported.	Quantity.	Pesos.
1917.			1919.		
Fresh fish...............colleras..	300,850	30,085	Fresh fish...............colleras..	153,164	15,316
Canned fish...............kilos..	26,667	5,333	1920.		
Dried fish...............do..	4,000	600	Fresh fish...............colleras..	245,350	24,350
Total...............		36,018	1921. (Jan. 1 to July 31.)		
1918.			Fresh fish...............colleras..	148,500	14,850
Fresh fish...............colleras..	189,694	18,970			
Canned fish...............kilos..	10,495	2,099			
Total...............		21,069			

The fish station at Montevideo (Alojamiento de Pescadores) reports that during 1920 there entered this port 8,633,940 pounds of fresh fish. Classified, they were as follows: 8,575,741 pounds of large

and 58,199 pounds of small fresh fish. Of the large fish 2,723,622 pounds were again exported and the rest consumed locally.

The following tables show the quantities of fish imported into Uruguay for the years 1915, 1916, and 1917. Countries of origin are given for 1917, while only the totals are given for other years:

Anchovy imports into Uruguay, 1915 to 1917.

Year and country of origin.	In oil.	Pickled.	Total.
	Pounds.	*Pounds.*	*Pounds.*
1915	557	35,682	36,239
1916	154	42,460	42,614
1917:			
Argentina	462	242	704
Spain	1,430	25,168	26,598
France	229	....	229
Italy	....	10,296	10,296
Total for 1917	2,121	355,706	37,827

The following imports of codfish were made during the year 1917 and from the following countries: Argentina, 128,100 kilos (281,820 pounds); Spain, 260 kilos (572 pounds); United States, 22,466 kilos (49,425 pounds); England, 40,260 kilos (88,572 pounds); and Norway, 1,200 kilos (2,640 pounds); a total of 192,286 kilograms (423,029 pounds) imported during the year. Imports for 1915 and 1916 were 395,953 kilograms (871,097 pounds) and 288,541 kilograms (634,790 pounds), respectively.

Imports of sardines into Uruguay, 1915 to 1917.

Year and country of origin.	In oil.	Pressed.	Pickled.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1915	179,137	74,470	7,322	260,929
1916	185,922	117,779	110	308,811
1917:				
Argentine	26,994	....	154	27,148
Brazil	189	....	....	189
Spain	79,600	53,020	9,075	141,695
United States	7,528	....	....	7,528
France	11,827	....	110	11,937
England	8,769	16,852	....	25,621
Portugal	13,323	....	....	13,323
Total for 1917	148,230	69,872	9,339	227,441

Imports of fish in general into Uruguay, 1915 to 1917.

Year and country of origin.	Pickled.	In boxes.	Dried.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1915	90,574	....	1,074	91,648
1916	34,214	1,907	220	36,341
1917:				
Spain	165	3,113	....	3,278
United States	25,476	....	....	25,476
England	1,056	....	....	1,056
Total for 1917	26,697	3,113	....	29,810

One firm furnishes a considerable part of the fish consumed at this port. This firm owns and operates two fishing vessels equipped to to carry 66,000 pounds of fish in their different compartments and also

has a station for depositing coal and ice and for taking water. The system of fishing used by this company is the "otter trawl," and the trips vary from one to six days. The one-day trip results in the catch of eight to ten thousand pounds of small fish, such as corbina, small hake, sole, marine crabs, sea urchins, lobsters, sea bream, conger eel, white braize, palometa, rayas, rayones, chuchos, sea fish, black corbina, criollas, sargos, brotola, borriqueta, whiting, crab, sea-wrack, etc. Deep-sea fishing requires longer voyages, usually from four to six days, and results in the catch of the following classes of fish: Merluza, castañetas, white braize, sea bass, ruffle, chanchitos, cod, quineos, mackerel, rougé, caballitos, canarios, soles, anchoa, horse mackerel, shrimp, potas, canadas, cuttlefish, moscardines, poulp, mussels, etc. These fish are caught in waters of 200 to 500 feet in depth, and it is stated that an average catch of a six-day trip of one vessel is about 33,000 pounds.

The firm has an agreement with the Bureau of Fisheries (Instituto de Pesca) to furnish it 50 per cent of all the common or small fish and 20 per cent of the "merluza" caught. Common fish are quoted at 5 centésimos per kilogram, or 2.345 cents per pound, and the fine or choice fish at 15 centésimos, or 7.03 cents per pound. The bureau resells the fish at 7 and 35 centésimos, respectively, or 3.3 cents and 16.4 cents per pound. It is stated that the prices quoted by this company are about 30 per cent lower than the wholesale quotations at the fish docks. Fresh fish are also sent to such interior towns as Artigas, Rivera, Melo, San Fructuoso, Trinidad, Durazno, Mercedes, and Minas.

[By William Dawson, consul at Montevideo, March 18, 1919.]

The Uruguayan Institute of Fisheries recently inaugurated a cold-storage and ice plant situated in one of the Montevideo port deposits. The plant is equipped with a Sulzer (Swiss) refrigerating outfit that can turn out 10,000 kilos (22,046 pounds) of ice in 24 hours. The initial cost of the machinery was about $30,000, while about $17,000 and $7,000 were spent on installation and plant, respectively. The capacity of the cold storage chambers is 600 cubic meters (21,188.7 cubic feet). A temperature of −20° C. has been obtained in the course of experiments. The primary object of the new plant is to furnish the ice and cold-storage facilities required by the institute for preserving and shipping fish for consumption at interior points.

ARGENTINA.

BUENOS AIRES.

[By W. Henry Robertson, consul general, October 19, 1921.]

According to information furnished by La Pescadora Argentina, one of the leading local fishing companies, the principal fishery products obtained in Argentina are fresh fish for domestic consumption, coming chiefly from the ports of Bahia Blanca, Mar del Plata, Necochea, and Montevideo, in the Republic of Uruguay, consisting of the following species: Corvina, pescadilla, pargo, anchovies sea bream, bonito, Limon, sole, conger eel, royal conger eel, raya, palometa, hake, squid, shrimp, and prawn. Fresh-water fish from La Plata River and its tributaries include pejerrey, shad, zurubi, pati, pacu, and other varieties of minor importance; from inland waters, pejerry; and from Rio Negro River, trout.

According to the Argentine National Bureau of Fisheries in Buenos Aires, from which most of the information in the report has been obtained, with the exception of the question of foreign imports of fish, the city of Buenos Aires consumes by far the greater portion of the fresh fish domestically produced or imported, and the most common varieties in the market of Buenos Aires are the following: Marine fish—brotula, conger eel, corvina, lisa, pescadilla, and raya; shell fish—mejillon, prawn, and shrimp; river fish—bagre, dorado, pati, pejerrey, and shad.

Selling prices of fish in Buenos Aires during 1920, according to species.

	Argentine paper per kilo.	United States currency per pound.		Argentine paper per kilo.	United States currency per pound.
Marine fish:			River and lake fish:		
Hake	$2.20	$0.42	Pejerrey grande	$1.38	$0.27
Sea bream	1.30	.25	Trout	1.00	.19
Brotula	1.22	.23	Pejerrey tipo filet	.95	.18
Bonito	1.13	.22	Eel	.81	.16
Sardine	1.03	.20	Pejerrey chico	.75	.14
Sargo	.97	.19	Dorado	.70	.13
Sole	.89	.17	Surubi	.69	.13
Pescadilla de red	.65	.12	Pacu	.60	.11
Anchovies	.62	.11	Pati	.58	.11
Burriqueta	.56	.10	River sardine	.45	.08
Anchoita	.56	.10	Boga	.43	.08
Lisa	.47	.08	Mandufia	.43	.08
Shellfish:			Tararira	.42	.08
Squid	5.12	.99	Mojarra	.27	.05
Cuttlefish	2.43	.47	Small shad	.21	.04
Prawn	1.55	.30	Armado	.17	.03
Brazilian oyster	.37	.07	Bagre	.13	.02
Shrimp	.35	.06			
Mejillon grande (a kind of cockle)	.35	.06			
Mejillon chico (same as above)	.28	.05			

The following statistics will show the greater part of the production of the national fishing industry during the year 1920, only the waters within the jurisdiction of the province of Buenos Aires having been taken into consideration, since it is in these that the exploitation of fish has its chief importance.

	Kilograms.
Fresh water:	
Parana River	548,101
Uruguay River	35,000
Estuary of the Plata	2,874,592
Inland waters	2,298,830
Total	5,756,523
Maritime:	
Buenos Aires zone—	
Mar del Plata	10,279,370
Bahia Blanca	1,891,685
Ajo	2,200,000
Quequen	400,000
Mira Mar	30,000
Patagonian zone—	
Port San Antonio	100,000
Gulfo Nuevo	1,000,000
Port Santa Cruz	150,000
Port Deseado	125,000
Port Gallegos	125,000
Port San Julian	100,000
Total	16,401,055

Summary of production of national fishing industry, Province of Buenos Aires jurisdiction, 1920.

	Kilograms.	Pounds.	Per cent of relative production.
Fresh-water production	5,756,523	12,690,830	26
Maritime production	16,401,055	36,157,765	74
Grand total	22,152,578	48,848,595	100

Entries of fresh fish and shellfish into Buenos Aires (1920) and origin thereof.

Month.	Maritime.	Lkae.	River.	Foreign.	Shellfish.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
January	1,317,404	186,692	230,340		158,774	1,893,210
February	1,485,484	219,758	225,522		89,727	2,020,491
March	1,306,426	328,515	340,890		63,261	2,039,092
April	1,666,698	339,570	369,820		89,078	2,465,166
May	1,601,688	326,128	441,980	66,880	59,675	2,496,351
June	1,209,648	290,770	425,040	276,463	35,684	2,237,605
July	868,912	273,944	489,720	403,700	56,243	2,092,519
August	1,176,384	311,520	441,408	326,205	156,596	2,412,113
September	1,082,576	15,400	619,300	390,236	147,059	2,254,571
October	1,302,488		519,464	369,248	72,222	2,263,422
November	1,727,616		39,204	282,062	197,175	2,246,057
December	1,727,792	268,488	273,900	179,366	131,450	2,580,996
Total	16,473,116	2,560,785	4,416,588	2,294,160	1,256,944	27,001,593

The consumption of fresh fish in the city of Buenos Aires, a city of about 1,700,000 inhabitants, amounts to a daily average of about 18 grams (0.71 ounce) per capita. An average of 65 cents, Argentine paper, per kilogram (12 cents United States currency per pound) was obtained for all kinds of sea fish, and an average of $1.30, Argentine paper, per kilogram (25 cent United States currency per pound), for all kinds of shellfish. The average price for all kinds of fresh-water river fish reached 55 cents, Argentine paper, per kilogram (10 cents United States currency per pound), while the product of the lake fisheries, chiefly pejerrey, sold at an average of $1.02, Argentine paper, per kilogram (19 cents United States currency per pound).

In spite of the best efforts and intentions toward this end, the interior markets of the Republic are deprived of the supplies of fresh fish, chiefly on account of the lack of refrigerating facilities and commercial organization in connection with the fishing industry. During 1920, 1,692,085 kilograms (3,729,355 pounds) of fish were sent from Buenos Aires, Rosario, La Plata, and Bahia Blanca to several towns of the interior. The Cordoba market, which is the most important inland city of the Republic, has had a monthly consumption of 7,890 kilograms (17,389 pounds) of fresh fish during the year 1920, while in the inland city of Tucuman the consumption of fresh fish reached an average of 27,000 kilograms (59,508 pounds) per month, only 30 per cent of the fish consumed belonging to the river fisheries. About 1,042,800 kilograms (2,298,330 pounds), with an approximate value of $484,920, Argentine paper ($205, 897 United States currency), were imported in 1920 from Montevideo and Brazil.

The methods employed in fishing in this Republic in either the sea, the rivers, or the lakes are extremely primitive. One company for-

merly had 11 trawlers but sold them to Russia at the beginning of the European war.

In spite of countless difficulties the first estimate of the potential fishing capacity of this nation was made in 1920. Of course, the maritime zone of the Province of Buenos Aires is the one occupying the largest place in the fishing industry, there being 784 men engaged in fishing therein, besides an additional number of 150 men who take charge of the land work connected with fishing. Although these numbers are not very small, only 15 per cent of the men engaged are of Argentine nationality and 74 per cent carry on their activities in the zone around Mar del Plata. It has been estimated that the capital invested in the whole of the maritime zone of Buenos Aires amounts to $885,655, Argentine paper ($386,049 United States currency). Of this amount 83 per cent corresponds to the value of the craft employed, 136 of which are motor vessels, with a total capacity of 1,006 metric tons. There are 82 sailing vessels, with a total capacity of 279 metric tons. The smaller craft number 161 vessels.

The means employed in the Patagonian zone are not as important as the above. There are only 58 fishermen, 20 per cent of whom are of Argentine nationality. There are also employed in land work 25 people in the preserve factories and other works. The capital invested in this large zone is very small, amounting to $142,445, Argentine paper ($59,547 United States currency). Of this amount 18 per cent corresponds to the value of the craft employed, 3 of which are motor vessels, with a total capacity of 17 tons. There are 11 sailing vessels, with a total capacity of 19 metric tons, the smaller craft numbering 10 minor vessels. Thus the national maritime fisheries have a total investment of $1,028,100, Argentine paper ($445,596 United States currency).

Regarding the river fisheries, which have not as yet a very great importance, it has been estimated that in the zone of the Rio de la Plata there are 147 people engaged in fishing, 20 of these being engaged in operations on land. However, the proportion of Argentine citizens is greater than in the maritime zone, as only 20 per cent of the total number of persons engaged are aliens. It must be specially borne in mind that the total capital invested in this zone amounts to $82,638 Argentine paper. Of this amount 27 per cent corresponds to the value of the craft employed, 8 of which are motor vessels, with a total capacity of 15 metric tons. There are 8 sailing vessels, with a total capacity of 15 metric tons. The smaller craft number 38 minor vessels.

There are 777 fishermen on the Parana River, only 4 of whom are permanently engaged in land work, 15 per cent of this total being Argentine citizens. The capital invested in this zone amounts to $144,006 Argentine paper. Of this amount, 41 per cent corresponds to the value of the craft employed, 242 of which are sailing vessels, with a total capacity of 280 metric tons. There are seven motor vessels, with a total capacity of 28 metric tons. The smaller craft number 77 minor vessels.

There are 56 fishermen in the Uruguay River zone, 6 of whom are engaged in permanent land work, 66 per cent of the total being Argentine citizens. The capital invested amounts to only $20,541 Argentine paper. Of this amount 62 per cent corresponds to the value of the craft employed, three of which are motor vessels, with a total

capacity of 9 metric tons. There are 6 sailing vessels, with a total capacity of 10 metric tons. The smaller craft number 32 minor vessels.

The river fisheries are represented by a total investment of $247,430 Argentine paper, and $1,028,100 Argentine paper has been invested in the maritime zone. There are about 60 men engaged in the lake fisheries, and the capital invested amounts to $60,000 Argentine paper. It is therefore evident that the fishing industry, in spite of the development so far attained, is carried on within a very limited sphere of action and with very primitive means, especially in the exploitation of the river zones.

The Argentine industries derived from fishing and sea game have not as yet been properly developed, in spite of the effort of some small industrials. The preservation of fish has not succeeded, notwithstanding the fact that the people of Argentina pay every year several million pesos for the preserved products of foreign manufacturers. There is at present a fish factory in Mar del Plata, which shows signs of actual progress on account of the great variety of local fish. This factory specializes in the preservation of fish in tin cans, both in oil and tomato sauce. It also produces some pickled fish. The following varieties are commonly employed at this factory: Pescadilla corvina (a kind of conger or sea eel) and anchovies (blue fish). At Puerto Madryn (Chubut) there are three small fish factories in operation. Their main products have been oil-preserved and pickled pejerrey and also filets of anchovies. This last variety has also been pickled and prepared in paste to a great extent and has had a great demand in the local markets.

At Ajo (Province of Buenos Aires) all the fishery output is turned into manufactured products. They prepare at this place a dried fish, using mainly a fish known as corvina. However, the methods employed in the preparation of this product are quite primitive. There are in Argentina five small factories manufacturing fish oil and fish-scrap fertilizers, chiefly from shad.

Regarding the sea game, in 1920 a total of 9,799 seals were killed, which rendered a good production of oil and furs. The oil output amounted to 1,460 hectoliters (38,568 gallons). Seals are found in the following places: Punta Buenos Aires, Punta Norte, Punta Ninfas and Isla Escondida, along the coast of the Territory of Chubut, and in the Playa del Fondo, in the Territory of Santa Cruz. Whales are killed in waters near Argentina, not under its control. The output of whale oil amounted to 27,000 barrels. The limited production of scrap and bones has not been taken into consideration. A small Norwegian fleet, although it never called at the national ports, also during 1920 captured in the southern seas 1,200 whales, which yielded 50,000 barrels of oil.

The compilation of official statistics was undertaken only a very short time ago. About 15 years ago the Argentine Government undertook to introduce fish culture, but operations have always been within a limited sphere of action and with elements inadequate to develop this kind of work to its highest degree. The starting point in this branch of activities may be found in the efficient cooperation of the Bureau of Fisheries, Washington, D. C., which furnished the eggs of some varieties of salmon, these varieties having been tested in the different appropriate regions of the Republic. Toward this end

there are maintained at present three unpretentious stations for propagation. The first is located on the shores of Lake Nahuel Haupi (Territory of Rio Negro) and specializes in the breeding of small river trout (*Salvelinus fontinalis*). Not less than half a million specimens of this variety are distributed every year in the appropriate waters along the Andes, in the Territories of Neuquen, Rio Negro, and Chubut. There are many streams in these Territories where this species has been successfully introduced. The second station is located at the foot of the Sierra de Aconquija, in the Province of Tucuman, and is especially devoted to the propagation of the rainbow trout (*Salmo irideus*). So far the adaptability of this species has been evidenced in numerous streams in the Provinces of Jujuy, Salta, Tucuman, Cordoba, Mendoza, and Buenos Aires. It has also been introduced with some success in the Santa Cruz River, in the Territory of Santa Cruz.

While foreign species are being cultivated without interruption, the fresh-water pejerrey (*Atherinichthys bonariensis*) is also being distributed in the inland waters, a breeding station for this purpose having been provisionally established at Olavarria, Province of Buenos Aires. No doubt this is the species having the greatest economic value and the one that prevails in the lake waters. Pisciculture is thus carried on by the Federal Government in the inland waters only. With the above exceptions, neither the Federal nor the Provincial Governments of Argentina are doing anything whatever to promote the fishing industry. No products of the Argentine fisheries of any class are exported nor are any foreign imported products re-exported to any material extent, although Paraguay might constitute a trifling exception in this respect. The only imports of fish into this country of importance are codfish cut and whole, canned fish, pickled fish, and sardines. Under the term "canned fish" are included salmon.

During the five-year period, 1910 to 1914, there were brought in 1,797,691 kilograms (3,954,920 pounds) of cut codfish, of a tariff valuation of $359,538. Of this 1,385,859 kilograms (3,048,890 pounds) came from Norway and 371,213 kilograms (816,669 pounds) came from Germany. During the year 1915 Norway furnished 168,000 kilos (369,600 pounds) out of a total of 181,356 (398,983 pounds). In 1916 Norway furnished 81,149 kilos (178,528 pounds), United States 26,063 kilos (57,339 pounds), and Brazil 12,000 kilos (26,400 pounds) out of a total of 133,000 kilos (292,600 pounds). In 1917 Norway furnished 27,536 kilos (60,579 pounds), United States 17,127 kilos (37,679 pounds), and the United Kingdom 5,862 kilos (12,896 pounds) out of total imports of 62,329 kilos (137,124 pounds). The imports of cut codfish in 1918 and 1919, respectively, amounted to 7,128 (15,682 pounds) and 15,491 kilos (34,080 pounds), it being impossible to give them by countries for those years, and the statistics of 1920 have not as yet appeared.

During the five-year period, 1910 to 1914, there were imported into Argentina 21,949,390 kilograms (48,288,658 pounds) of codfish, whole, of a tariff valuation of $3,072,914. Of this quantity Norway furnished 14,389,569 (31,657,051 pounds), the United Kingdom 4,722,009 (10,388,420 pounds), and Germany 2,387,519 (5,252,542 pounds) kilograms, 14 other countries furnishing the small remainder. In 1915, 3,788,563 kilos (8,334,839 pounds) were imported in all, of which

Norway furnished 3,443,747 kilos (7,576,243 pounds). In 1915 Norway furnished 1,755,941 (3,863,070 pounds) out of a total of 2,035,448 (4,477,986 pounds) kilos. In 1917 Norway furnished 1,051,121 (2,312,466 pounds), the United States 447,079 (983,574 pounds), and the United Kingdom 355,331 (781,728 pounds) kilos out of a total of 1,872,347 kilograms (4,119,163 pounds). In 1918 and 1919, 615,627 (1,354,379 pounds) and 1,507,439 kilograms (3,316,366 pounds) of whole codfish were imported, respectively.

Canned fish.—During the five-year period, 1910 to 1914, 7,220,617 kilograms (15,885,357 pounds) of canned fish were imported into this country, with a tariff valuation of $2,527,214. Of these imports Italy furnished 2,007,335 kilos (4,416,137 pounds), Spain 1,866,392 kilos (4,106,062 pounds), the United States 1,096,230 kilos (2,411,706 pounds), the United Kingdom 919,676 kilos (2,023,287 pounds), France 766,470 kilos (1,686,234 pounds), and Canada 259,292 kilos (570,442 pounds), 15 other countries furnishing the small remainder.

The following were the imports of canned fish by countries during the three years, 1915 to 1917:

Country of origin.	1915	1916	1917	Country of origin.	1915	1916	1917
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Spain	408,628	544,438	441,179	France	43,815	46,990	28,974
United States	292,358	308,216	292,992	Other countries	28,701	37,684	23,954
Italy	473,774	486,812	119,724				
United Kingdom	284,115	331,954	50,250	Total	1,531,391	1,756,094	957,073

In 1918 and 1919, respectively, there were imported 674,258 and 658,879 kilos (1,483,368 and 1,449,534 pounds) of canned fish from all countries.

Pickled or pressed fish.—During the five-year period, 1910 to 1914, there were imported into this country 6,640,812 kilograms (14,609,786 pounds) of pickled or pressed fish, with a customs valuation of $996,122. Of this quantity Spain furnished 3,894,313 kilos (8,567,489 pounds), Holland 979,341 kilos (2,154,550 pounds), Italy 932,514 kilos (2,051,531 pounds), France 106,173 kilos (233,581 pounds), United Kingdom 75,454 kilos (165,999 pounds), Portugal 67,837 kilos (149,241 pounds), and United States 8,472 kilos (18,638 pounds).

During the next three years the imports were as follows:

Country of origin.	1915	1916	1917	Country of origin.	1915	1916	1917
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Spain	1,888,924	1,534,889	1,871,540	United States	29,304	7,561	35,594
Italy	216,931	191,068	81,754	Other countries	64,275	40,282	121,053
United Kingdom	13,187	116,635	37,356				
Holland	436,498	109,721	273,957	Total	2,649,119	2,000,156	2,421,254

During the years 1918 and 1919, respectively, there were imported into this country 833,411 and 1,188,494 kilos (1,833,504 and 2,614,687 pounds) of pickled or pressed fish.

Sardines.—During the period 1910 to 1914 there were imported into this country 20,064,581 kilos (44,142,078 pounds) of sardines, with a tariff valuation of $5,018,143. Of these imports Spain furnished 14,189,046 kilos (31,215,901 pounds), Norway 2,683,783 kilos

(5,904,323 pounds), Portugal 1,263,284 kilos (2,779,225 pounds), France 862,465 kilos (1,897,423 pounds), United Kingdom 372,727 kilos (819,999 pounds), Italy 209,041 kilos (459,890 pounds), and the United States 77,951 kilos (171,492 pounds).

During the next three years the imports were as follows:

Countries of origin.	1915	1916	1917	Countries of origin.	1915	1916	1917
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Spain	3,178,595	5,821,759	3,359,257	Italy	262,339	92,261	948
Portugal	117,269	293,735	130,801	United Kingdom	64,643	150,891	191,888
United States	150,271	268,488	261,094	Other countries	15,008	6,701	143
Norway	1,624,874	176,189	10,296				
France	291,568	142,494	140,540	Total	5,704,567	6,952,518	4,094,967

During 1918 and 1919, respectively, there were imported 1,418,641 and 2,458,253 kilograms (3,121,010 and 5,408,157 pounds) of sardines.

The standards imposed on imported canned salmon by the National Department of Health make it very difficult to work up a substantial trade for the American article in this market. The high import duties, surtaxes, and other charges are also detrimental. These obstacles apply, of course, to canned salmon from other countries as well, but they operate more unfavorably against our own salmon, because Americans are more apt to become discouraged in the face of such impediments and to give up the market than Europeans.

It will have been seen from the foregoing statistics of this report that the preferred products such as sardines, canned salmon, dried codfish, etc., come from European countries, and it is considered that the reasons for such preferment are chiefly the following:

(*a*) European brands have been advertised and introduced here, and are much better known than the American, because Europe made a bid for the Argentine market long before the United States did so.

(*b*) European prices before the war were uniformly lower than those of the United States, because of the lower producing costs, chiefly in the form of lower wages in the industries.

(*c*) Freight rates from Europe have always been lower than those from the United States, with the additional advantage to European producers of the ability to take back return cargoes of cereals and other Argentine products that the United States did not need.

(*d*) European selling terms, credits, etc., have always been more favorable to purchasers than the American because of the keen competition between the various European countries.

(*e*) The large Spanish, Italian, French, and English colonies in Argentina are accustomed to consume the products of their respective countries, while the American colony here is comparatively unimportant in numbers.

(*f*) It is only within the last six or seven years that special attention has been devoted here by one or two American importers to the canned products of our Pacific coast, but it is believed that this trade must necessarily increase in view of the comparatively recent creation of a direct steamship line from Washington, Oregon, and California down the west coast to Latin America, through the Straits of Magellan, up the east coast, and through the Panama Canal on the return trip to those States. There is at present at least a monthly freight

service of this character, and it is believed that more frequent steamers will be used later on.

(*g*) As a rule Argentina, a great cattle-raising country, has produced beef and mutton so cheaply as to decrease the consumption of either domestic or foreign fish to a considerable extent, especially in the interior of this Republic, to which freight rates from the seaboard are so high.

(*h*) The quality of the corresponding European products has generally been considered superior to that of the American.

(*i*) The heavy exchange premium that has ruled now for about 16 months in favor of the American dollar as against the Argentine paper peso makes business of all kinds here in American products very difficult and in most cases prohibitive, and has correspondingly, of course, favored European competition in almost all lines.

The possibilities of increasing American imports will be more and more expanded as American products are more and more advertised and handled here by responsible importers and the various brands become better known. There will always be serious competition, however, from Europe in the special articles under discussion.

WEST INDIES.

CUBA.

HABANA.

[By Theodore M. Fisher, vice consul, August 29, 1921.]

The principal local fishery products in the Habana consular district are fresh fish, shrimp, oysters, and lobsters, and a small quantity of canned lobsters, squids, oysters, and turtles. The methods employed in obtaining these are practically the same as those in use in the United States.

Nearly all fish, shrimp, oysters and lobsters are sold fresh; none are dried or cured. It is understood that the methods employed in the small canning factory at Batabano are the same as those used by American canneries.

No fishery products are exported. Statistics of imports for the last two available years, by kinds, value, and countries of origin, are appended to this report. No imported fish products are reexported.

Preferential rates of import duty between Cuba and the United States, cheaper freight rates, nearness of the island to the United States and excellent transportation facilities, including a daily car ferry service, give American products a decided advantage over all other foreign fishery products.

American fishery products are not well advertised in Habana. It would therefore appear that an extensive advertising campaign conducted along the same lines as those in general use in the United States would increase the sale of these products. It is believed that samples of canned salmon, etc., placed in the retail groceries would increase the sale of canned products especially.

It is stated that the prices of fish products in Cuba are much higher than those in the United States and are not justified, even taking into consideration excessive transportation charges and rates of duty.

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Importation of fish products into Cuba, 1918 and 1919.

Product and country of origin.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Codfish:	*Pounds.*		*Pounds.*	
United States	11,471,824	$1,751,939	10,524,319	$1,751,529
Canada	18,815,376	2,418,465	18,197,822	2,924,331
Great Britain	131,592	29,442	132,905	42,219
Norway	55,313	9,192	370,949	64,754
Japan	16,841	5,077	258,853	48,365
Colombia	5,755	320	10,995	202
British West Indies	3,370	500		
Canary Islands	2,875	87	18,114	474
Holland	1,690	39		
Spain			2,178	320
Total	30,504,636	4,215,061	29,516,135	4,832,194
Herring:				
United States	511,439	41,633	1,081,703	94,901
Canada	340,744	32,316	322,973	31,750
Canary Islands	80,520	3,214	59,705	2,142
Spain	53,124	3,792	65,325	8,512
Colombia	9,530	314	7,627	402
China	5,660	758	16,154	2,615
Norway	2,246	210	5,170	453
Holland	1,190	88		
Mexico	803	37	1,622	200
Japan	61	9	3,464	1,878
Great Britain			3,349	282
Total	1,005,317	82,371	1,567,092	143,135
Mackerel:				
United States	49,600	4,991	126,680	12,850
British West Indies	48	10		
Canary Islands			2,013	72
Japan			1,394	244
Canada			738	90
Spain			110	6
Total	49,648	5,001	130,935	13,262
Salmon:				
United States	4,554	489	8,198	1,287
France			271	25
Japan			16	12
Total	4,554	489	8,485	1,324
Canned salmon:				
United States	384,914	43,012	1,686,062	177,363
Canada			311,377	33,832
Total	384,914	43,012	1,997,439	211,195
Canned sardines:				
United States	4,448,756	604,726	6,041,849	640,664
Canada			316,122	36,489
Spain	18,379	3,068	6,248	1,474
France			693	429
Portugal			169	89
British West Indies	103	5		
Total	4,467,238	607,799	6,365,081	679,145
Other canned fish:				
United States	2,378,598	315,433	2,571,565	301,183
Spain	1,328,219	264,719	3,254,915	528,755
Canada			179,859	20,570
China	35,922	4,042	18,154	2,312
Japan	10,615	1,753	5,368	1,400
France	1,740	577	4,732	2,547
Great Britain			2,867	546
Canary Islands			779	91
Holland			220	74
Venezuela	22	9		
Total	3,755,116	586,533	6,038,459	857,478

Importation of fish products into Cuba, 1918 and 1919—Continued.

Product and country of origin.	1918.		1919.	
	Quantity.	Value.	Quantity.	Value.
Oysters:				
United States	1,170	$136	15,226	$1,631
Other shell fish:				
United States	508,583	195,676	6,502,232	138,851
China	10,718	2,478	21,749	5,671
Japan	1,210	444	2,057	906
Spain	1,243	80		
Canary Islands			634	30
Mexico	106	12		
Total	521,860	198,690	6,526,672	145,485
Fresh fish:				
United States	1,065,533	35,053	1,315,376	82,434

MATANZAS.

[By C. B. Hosmer, vice consul, August 30, 1921.]

Only fresh fish are supplied to the local market in this consular district by means of local industry. A sufficient amount of very good fresh fish to supply Matanzas and the surrounding territory is brought in by local fishermen each day. Only a sufficient supply to meet the demand each day is caught, as in this climate fresh fish must be used at once, and even with refrigeration it is not desirable as food after a short time. The fishermen use small fishing schooners, sailboats, and rowboats for their work and are provided with nets, lines, and other accouterments necessary to take the fish which abound in these waters. No effort is made to cure any of the fish brought into this port, and any surplus becomes waste, although this seldom occurs.

No fishery products are exported, as would necessarily be the case from the facts already stated, and no such products are reexported, except possibly some chance shipment which has been refused by its consignee. As in practically all parts of Latin America, cured fish, and particularly dried cod, is one of the chief articles of diet in Cuba and is therefore a large import in Matanzas as in other Cuban ports.

I am advised by the customs authorities of this port that there has been a very marked change in the proportion of fishery products imported into Cuba from foreign countries during the past two years and that the latest published statistics—that is, for the fiscal year July 1, 1918, to July 1, 1919—would give a very erroneous idea of the subject. The collector of customs has therefore very kindly compiled the statistics for the first seven months of 1921 for this report and informs me that while he is not in a position to furnish these statistics for 1920 he can assure me that they are in virtually the same proportion, though much larger in volume, than the first seven months of this year.

Importation of fishery products at Matanzas, Cuba, Jan. 1 to July 31, 1921.

Country of origin.	Dried cod.	Dried herring.	Sardines.	Tunny-fish.	Other fish.	Dried shrimp.	Canned shrimp.
	Pounds.	*Pounds.*	*Cans.*	*Cans.*	*Cans.*	*Pounds.*	*Cans.*
United States	410,918	7,634	5,623	1,730	1,716	5,282	2,947
Norway	162,023						
Spain			15,093		54,288		
Total	572,941	7,634	20,716	1,730	56,004	5,282	2,947

Special attention is invited to the large importations of dried cod from Norway, which country now stands second to the United States in exporting this commodity to Cuba. Importations from Norway are increasing, and the product received is regarded in this market as of excellent quality. It should also be noted that the proximity of Habana makes it possible for dealers to procure such articles as they do not care to purchase in large quantities from wholesale merchants in that market.

All fishery products of the United States, with the exception of sardines and other fish preserved in oil, are imported in larger quantities than from other nations. Until recent years Canada has led the United States in the importation of dried cod, but during the past two years the United States has taken the lead in imports of this article. Whether Canada will again obtain the leadership in the market for dried cod, which is an important article of import, will doubtless depend on the output of Canadian fisheries and whether an effort is made to increase Canadian sales in this market.

There is a good demand here for such fishery products as are produced for export in Spain, France, and Scandinavia, and as a large part of the merchants here are of Spanish nationality there is a natural tendency for them to purchase Spanish goods whenever the price and quality are comparable to those obtainable from the United States. Spanish and French sardines find favor in this market. This preference is claimed to be due in some measure to the fish used but principally to the superior oil used in the Spanish and French products. This reasoning applies to all fishery products preserved in oil.

It is believed that keener competition from Europe and Canada can be looked for in this market and that American exporters should endeavor to prepare themselves to meet this competition and retain the very marked leadership which American fishery products now enjoy here if it is possible to do so. Any propaganda or change in the preparation of canned fishery products sent to this market that will do away with the belief current here that American products of this class are inferior to those from Europe will be helpful.

ANTILLA.

[By H. C. von Struve, consul, August 29, 1921.]

This consular district produces no fishery products of any kind except a small quantity of fresh fish, usually not sufficient to amply supply local needs. No fishery products of any kind are exported or reexported. The imports of fishery products into this district as

shown by the latest statistics published by the Cuban Government were as follows:

Kind.	1918		1919	
	Pounds.	*Value.*	*Pounds.*	*Value.*
Cod	583,135	$75,694	1,092,648	$152,939
Herring	54,985	5,149	123,182	11,067
Mackerel	27,822	2,820	67,426	6,129
Salmon	812	88	1,185	107
Canned Salmon	16,376	2,500	271,872	34,708
Sardines	264,714	35,157	122,326	14,576
Other fish	32,399	5,044	75,496	10,516

No statistics are available showing the countries of origin of the above imports into this district, but it is presumed that they come from the same countries and in the same proportions as similar imports for the entire Republic of Cuba, shown in the following table:

Product and country of origin.	1918	1919
Codfish:	*Per cent.*	*Per cent.*
United States	37	34
Canada	63	66
Herring:		
United States	50	74
Canada	34	23
Various countries	16	3
Mackerel: United States	[1] 100	[1] 100
Salmon: United States	[1] 100	[1] 100
Canned salmon:		
United States	[1] 100	[1] 84
Canada	....	16
Sardines: United States	[1] 100	[1] 100
Other fish:		
United States	65	44
Spain	35	56

[1] Practically.

There is no preference for fishery products of Canada over those of the United States, and the only reason assignable for the importations from Canada is that possibly the supply in that country was more ample, leading to better price offerings. The small imports from Spain are due chiefly to the preference of the large number of Spanish-born inhabitants of the district for some of the products of their native land.

As the district is believed to be importing as large a quantity of fishery products as its buying capacity will warrant, the source of supplies will depend on price offerings. Imports from the United States have a 25 per cent tariff advantage, and in addition American exporters have the advantage of more favorable shipping facilities.

CIENFUEGOS.

[By Frank Rohn, consul, November 16, 1921.]

Practically the only fishing industry in any of the ports of this consular district is the catching of fish which are nearly all sold fresh in the local markets or peddled from house to house. The principal varieties are the red snapper (Pargo), sawfish (Sierra), ruffle (Cherna)

resembling the salmon, and the lobster, shrimp, and oyster. Some fresh fish are also packed in ice and shipped to interior places, and lobster and shrimp are at times likewise sent to Habana.

There is practically no curing nor canning of fish here, and hence no exportation of fishery products. The American consular agent at Caibarien reports that some mullet is salted and cured in that district but is subsequently sold in the domestic market. Lobster from the island of Turiguano, canned at Batabano, Cuba (Habana Province), is, however, sold to a considerable extent here. Various imported cured and canned fish varieties are sold in this district, but the official statistics indicate that by far the principal part of the Cuban importation is via the ports of Habana and Santiago.

The following table, compiled from official sources, gives the direct importation of the principal fish varieties for the last three years at the port of Cienfuegos:

Product imported.	1918	1919	1920	Product imported.	1918	1919	1920
Codfish (cases or bales)	7,550	2,244	6,363	Herring (cases)	....	460	....
Cod and other fish (tubs)	500	170	1,564	Sardines (cases)	4,077	5,520	10,252

Other canned fish varieties are also imported direct into this port, but they are classed under the general heading of canned meat and fish. Both the white and black nape codfish are imported into this district; also in more limited quantities, boneless cod and herring in individual tins or packages, as well as tunny, hake, merluse, shrimp, and lobster, also in tins. As far as has been ascertained there is no reexport of imported fishery products from any of the ports of this consular district, and it is understood that any such reexport from Cuba is from the port of Habana.

Dried cod, sardines, canned salmon, and other fishery products produced in the United States have in the past also been imported in considerable quantities from other countries, and it is understood that with the gradual return to normal conditions since the war, such importation from other sources of origin is again being revived. This preference is again asserting itself particularly in the case of Norwegian codfish, which is said to be of better quality and to be preferred in all parts of the district to the American product. Spanish and Norwegian sardines are also again establishing themselves in this market, both being considered superior in quality to the American product. Since the population here is largely Spanish, the sardines from Spain are put up more in accordance with popular taste.

This market for non-American products is being established in spite of the 25 per cent preferential duty to the United States resulting in higher prices for the non-American products and in spite also of the fact that in general the American tins are larger. The following table gives a comparison of the present wholesale prices per case of varying number of tins of American and non-American fishery products:

Product.	Tins per case.	Wholesale price per case.
Dried cod:		
American		$9.50
Norwegian		11.00
Sardines:		
American	48	7.50
	100	5.00
Norwegian	100	8.50
Spanish	100	7.00
Salmon:		
American	48	7.50
		9.00
	96	8.00
		9.50
Salmon—Continued.		
English	100	$12.00
Tunny, hake, and merluse:		
American	60	18.00
Spanish	60	25.00
Oysters: American	100	33.00
Shrimp: American	48	8.00
Lobster:		
American	48	32.00
Cuban	48	15.00

American firms who desire to establish or increase a market for fishery products in this district are advised to communicate, preferably in the Spanish language, with the principal wholesale importers in this line and the principal commission agents in the provision lines. Since many fishery products are imported into this district via Habana, which is understood to be a much more important market for these products, any general agency or importing house for the entire island should, of course, be established at that place.

SANTIAGO.

[By Harold D. Clum, consul, January 24, 1922.]

There are no fisheries in this district, as the term is generally understood. Fish are not exported nor are they caught in large quantities and cured. The fish caught in the vicinity of Santiago are not sufficient in quantity to meet local demands, and some are shipped in by express from Manzanillo. Fish are not plentiful in the market of any town in this district, with the exception of Manzanillo, and even there fishing is not an industry of considerable importance. The fishing is done mostly with lines from small motor boats, sailboats, and rowboats, and the principal varieties caught are the red snapper and Spanish mackerel. Some seine and trap fishing is done in the ports. The fish imported into this district are principally cured cod, herring, and mackerel, and salmon and sardines in tins. The following tables show the imports of the principal ports of the district in 1918 and 1919, from statistics published by the Cuban Government. Figures for 1921 are not yet available nor are complete figures for 1920 except as to imports from the United States.

Port.	1918		1919	
	Pounds (gross weight).	Value.	Pounds (gross weight).	Value.
Codfish:				
Guantanamo	90,827	$12,220	448,899	$67,250
Manzanillo	381,801	45,657	518,333	67,380
Santiago[1]	9,870,694	1,236,166	9,111,781	1,359,702
Total	10,343,322	1,294,043	10,079,013	1,494,332

[1] 1920 statistics furnished by the Santiago customhouse show 8,692,859 pounds, gross weight, valued at $1,086,978, for Santiago.

Port.	1918		1919	
	Pounds (gross weight).	Value.	Pounds (gross weight).	Value.
Herring:				
Guantanamo	66,037	$6,983	57,209	$6,211
Manzanillo	5,128	104	20,305	1,962
Santiago	247,490	22,662	216,276	26,440
Total	318,655	29,749	293,790	34,613
Mackerel:				
Guantanamo	10,693	1,061	13,665	1,609
Manzanillo			1,333	180
Santiago	4,882	768	37,619	4,364
Total	15,575	1,829	52,617	6,153
Salmon, cured:				
Guantanamo	2,025	218	805	79
Santiago	1,084	116	2,938	319
Total	3,109	334	3,743	398
Salmon, tinned:				
Guantanamo			76,423	9,892
Manzanillo	9,698	1,130	44,053	4,811
Santiago	247,193	24,399	723,255	78,380
Total	256,891	25,529	843,731	93,083
Sardines:				
Guantanamo	48,905	6,867	45,459	4,994
Manzanillo	134,299	20,486	120,214	13,254
Santiago	1,625,927	219,088	1,249,257	136,404
Total	1,809,131	246,441	1,414,930	154,652
Other fish, tinned:				
Manzanillo	3,461	491	68,041	9,306
Santiago	48,407	7,603	171,509	31,195
Total	51,868	8,094	239,550	40,501
Shellfish:				
Guantanamo	547	273		
Santiago			16,440	5,082
Total	547	273	16,440	5,082

Statistics showing countries of origin of imports into this district are not available, but the following percentages, taken from published statistics for the island as a whole for 1919, may, with some exceptions, be taken as applying to this district. Owing largely to the direct steamship service between Halifax, Nova Scotia, and this port, more than 95 per cent of the codfish imported here comes from Canada.

Product.	United States.	Canada.	Spain.	Product.	United States.	Canada.	Spain.
1919.	*Per cent.*	*Per cent.*	*Per cent.*	1919.	*Per cent.*	*Per cent.*	*Per cent.*
Codfish	36	60		Sardines	94	5	.2
Herring	66	22	6	Other fish	35	2	61
Mackerel	97			Shellfish	95		
Salmon (tinned)	84	11					

Imports of fish from the United States in 1920 were as follows, according to data supplied by the collector of customs of this port:

Product.	Pounds (gross weight).	Value.	Product.	Pounds (gross weight).	Value.
1920.			Salmon (tinned)	481,578	$44,343
Codfish	270,097	$33,946	Sardines	1,272,722	130,673
Herring	213,765	17,380	Other fish	189,377	36,633
Mackerel	52,658	4,992			
Salmon (cured)	405	35	Total	2,480,602	268,002

There is no reexport of imported fish products. Codfish comes here principally from Nova Scotia, in drums of 128 pounds, net weight, about 3,000 drums being imported monthly. Very little comes from the United States. This fish costs about $10 a drum, c. i. f., from Canada. Merchants state that American codfish usually costs about $1 a drum more than the Canadian, and they do not consider that it is as well cured or seasoned. These considerations, together with the convenience of importation by direct steamers of the Pickford & Black Line from Halifax, give the market to the Canadian codfish.

Normally 500 to 600 5-pound boxes of dried herring (bloaters) come into this port each month, principally from New York, but to a certain extent from New Brunswick. Importations of this fish have fallen off during the past year, owing to the departure of the Jamaicans (the chief consumers), on account of hard times and lack of employment. A limited amount of salted mackerel is imported in 100-pound barrels. This comes chiefly from New York and is brought in principally for consumption during Lent.

The salmon imported here is the grade known to the trade as chum salmon. The greater part comes from the United States, though no distinction is made as to the quality between American and Canadian salmon. What is known as "Alaska" salmon is preferred, some of which is shipped from Vancouver as well as from the Pacific coast of the United States. No red salmon is brought here.

Spanish sardines are preferred for quality, but large quantities of California sardines, larger and coarser fish than the Spanish sardine, are imported because they are cheaper. In this district the greater part of the sardines consumed come from the United States, as the market demands cheaper grades. French sardines are packed in fancy style and are expensive, and for this reason few are imported here. A limited amount of assorted fish, such as bonito, merluza, tuna, etc., comes from Spain.

ISLE OF PINES.

NEUVA GERONA.

[By Charles Forman, consul, September 21, 1921.]

There are various kinds of fish found in the waters surrounding the Isle of Pines, and some are used locally for food but always in a fresh condition. No fish are cured here or otherwise prepared for shipment elsewhere. No fish or fish products are exported.

The fish products imported are dry-salted cod and salmon, sardines, and some oysters and clams in tins. Owing to the fact that the imported fish products consumed in this island, especially the codfish, are chiefly purchased in Havana, no statistics of imports can be given. The codfish are mostly the whole fish, containing the bones, packed in 100-pound boxes, and originate in the United States, Norway, and Nova Scotia. The American cod is a little the cheapest, the Norwegian being of a little better quality and higher priced. The canned salmon and canned oysters and clams are American, the sardines mostly American, with some from Norway and Spain, which are higher priced. There is no reexport of fish products. This island has some trade with Grand Cayman, some cattle being imported from that island, but it is understood that fish products imported into the island mentioned are from Jamaica or the United States. The merchants who deal in fish products in the Isle of Pines are general merchants and grocers.

As the bulk of the fish products consumed here is American, it is not believed that much can be done to increase American trade in these lines. The population of the island in 1919 was 4,228. About 60 per cent of the inhabitants are Cuban citizens of the white race, mostly poor or in quite moderate circumstances. Of the remaining 40 per cent about one-half are Americans and the other half negroes of various nationalities. The American residents form, on the whole, the most prosperous class in the island. Agriculture, transportation, and banking are mostly carried on by them. The number of well-to-do people is therefore small, and there is not much demand for expensive goods.

HAITI.

PORT AU PRINCE.

[By Robert W. Longyear, vice consul, September 23, 1921.]

The fishing industry, in common with other industries of Haiti, is extremely primitive. There are no companies or combinations to organize fishing on any scale. If a man has a sailboat and a net, he becomes a fisherman; and if he loses one or the other and can not replace what he has lost he may become a farmer or a laborer. However, since Haiti has a great coast line and since its waters abound in fish it has a considerable proportion of its poorer population engaged in the fishing trade. Just what proportion it is impossible to state, for there are no statistics available even for a moderately accurate census.

The principal local fishery products are restricted to the fish themselves. No facilities for extracting or using by-products have been developed. There are five kinds of fish that are sold in the market fresh, as follows: Letaza, Saad (red snapper), Bousse, La Lune (moonfish), and sardine. Lobsters and shrimp are also among the fishery products.

Fishermen use nets and traps to get their products. Both are of native quality and workmanship, necessarily primitive and inefficient. The nets are the usual buoyed variety and the traps are wicker-work mazes baited with a fish head at the interior. These traps are about 4 feet square and 2 feet high and are lowered to the bottom in about 12 feet of water, where they are left for an indeterminate period and then hoisted and emptied of all that may be

found in them. As may be seen, fishing is hardly a skilled occupation.

Fish are always brought to market fresh, and the market folk who buy them keep them for a day, more or less, and then clean and salt them themselves. This, of course, means that one can never have a guaranty of the freshness of a fish. The total fish product is consumed locally, there being not even intercommunal trade except with inland towns, and no exporting is done.

Salt cod is the only fish imported in any large quantities. Sardines and anchovies are brought in in small quantities from France. The value per pound of products imported from France is, roughly, eight times that of the United States.

There is no reexport of imported products. Haiti has no industry except agriculture and its dependent works, such as cigarette factories and sugar mills. The small amount of sardines and tinned fish that is imported is hardly worth analyzing, and the convention between France and Haiti does not specifically include sardines in the general 33⅓ per cent reduction of duties. The general sale of French sardines and anchovies is mostly due to the superior quality and better reputation of French products, aided by the paternal attitude of France toward Haiti and the natural close feeling between two countries speaking the same language. All this, however, is purely relative, for while the French products are sold to a greater extent than the American the whole amount involved is extremely small.

The balance of trade is so tremendously in favor of the United States at present that any increase in fish products coming in must either be in a wider consumption of more expensive fish, which is practically impossible at present, owing to the extreme depression now prevailing in the Republic, or in the creation of markets for by-products. This latter field is untouched in Haiti, because there are no industries which deal in such, and, so far as one can judge, there never will be any great or extensive manufacturing or industrial plants on the island while nature's products grow so well and cheaply.

CAPE HAITIEN.

[By Avra M. Warren, consul, September 30, 1921.]

In this consular district native fishermen catch sea turtles, shrimp, lobster, and fresh fish for daily local consumption. The fishing is done with small seines, or by fish and lobster pots, or by trolling from small sailboats. There is no curing of fish in the consular district.

No fishery products are exported. Salt, dried, and smoked herring, mackerel, and cod were imported into Haiti for the year September, 1919, to September, 1920, from the United States and France, as follows: From the United States, 4,854,339 pounds, valued at $639,621; from France, 3,583 pounds, valued at $4,163; and from other countries, 80,780 pounds, valued at $3,546. There is no reexport of imported fish products.

The only fish products imported from countries other than the United States are mackerel and herring, pickled or prepared in a manner exclusive to the country of exportation. As the import statistics indicate, the American market has a monopoly of the fishery products imported into Haiti.

DOMINICAN REPUBLIC.

PUERTO PLATA.

[By W. A. Bickers, consul, August 27, 1921.]

The local fishing industry is confined to a few men with small boats who, in part, supply the coast towns with fresh fish. No efforts are made to ship fresh fish to the towns in the interior nor to dry or cure or preserve fish in any way nor are there any exports or reexports of fishery products.

The imports of fishery products are very important, as can be seen from the following table of imports into the entire Republic for the year 1920:

Articles.	From United States.	From all countries.	Articles.	From United States.	From all countries.
1920.	*Pounds.*	*Pounds.*	1920.	*Pounds.*	*Pounds.*
Pickled fish	557,812	565,996	Smoked fish	1,790,226	1,795,163
Salted or dried fish	4,475,401	4,618,478	Canned or preserved fish	1,886,245	2,069,951

The imports of fish in 1920 were about double those of the years immediately preceding and will exceed the imports of any year for many years to come, but from the above table it is evident that American fish products predominate in this market, although it is not likely that the small quantities secured from other sources can be eliminated, as these quantities represent the individual preference of small groups of Europeans resident here. Although quantities of imported fish products were much greater than usual in 1920, the percentages secured from various countries have shown very small changes during the past years, as the United States has always been the source of supply for the bulk of the imports of this character.

The bulk of the imports is composed of the cheaper grades of cod, mackerel, and herring. The price of the article is more important than the quality except for canned or preserved fish, as the poorer classes can not afford to purchase this kind of fishery product. Canned or preserved fish of good quality is desired, as the wealthier classes here are willing to pay high prices for the brands which meet their favor. As the various kinds of fishery products are on sale in all parts of the country, it is very doubtful if there is any way to materially increase the consumption.

SANTO DOMINGO.

[By Geo. A. Makinson, vice consul, September 3, 1921.]

The inhabitants of the Dominican Republic, like the residents of all other West Indian Islands, are heavy fish eaters, but as the fishing industry in this country has not been developed beyond the embryo stage it is unable to supply even the needs of the home market, and appreciable quantities of dried, smoked, and preserved fish products are imported from other countries.

The Dominican fishing fleet consists of about 50 small sloops and dories, manned by from two to four men each, none of which has been especially designed for this trade. Gasoline boats are not used.

There are no fishing banks or other spots near this island where fish are known to be especially plentiful, so that the fleet operates along the entire coast. Modern American-made nets are in general use, and in addition a limited number of hand lines are employed. None of the fishing vessels carry ice for packing fish; consequently they do not remain out of the port more than a few hours. The principal fish caught in local waters are red snapper, gilt heads or dorado, barracuda, perch, shad, and jurel. The three first-mentioned classes retail at 50 cents a pound; the others, at 30 cents per pound. The daily consumption of fresh fish in Santo Domingo, the capital and largest city of the Republic, does not exceed 150 pounds. No fish are caught in any of the Dominican rivers. Occasionally small sea crabs are offered for sale in the public markets, but neither oysters, clams, nor shrimp are obtainable. Fish are neither cured nor exported.

Fish imports into the Dominican Republic aggregate nearly $1,000,000 per annum, and at least 95 per cent of these imports originate in the United States. Owing to the absence of highways, which renders transportation slow and costly, and also to the fact that very few merchants in the interior towns possess ice boxes or other means for keeping fresh fish, the residents of these towns rarely ever see Dominican fish and depend entirely upon imported sea foods.

The following table shows the classes, quantities, and values of fish importations into the Dominican Republic during 1919 and 1920:

Class.	1919		1920	
	Pounds.	*Value.*	*Pounds.*	*Value.*
Pickled fish	446,864	$34,562	565,996	$37,357
Dried or salted	262,401	325,994	4,618,478	432,896
Smoked	991,705	105,011	1,795,163	160,731
Canned or preserved		171,213	2,069,951	331,575
Total	1,700,970	636,780	9,049,588	962,559

Smoked products (bloaters) brought into this country are packed in 15-pound wooden boxes and retail at from 3 to 5 cents each, according to size. Haddock is the principal dried or salted fish imported into this market. It is packed in 120 and 480 pound drums and retails at 12 cents per pound. Salmon and tuna constitute the great bulk of tinned importations. Ordinary grades sell as low as 20 cents, while the best quality brings 75 cents per pound. Sardines are generally sold in ¼ and ½ pound tins, at from 15 to 60 cents, depending on quality. There are no reexports of fish products. American fish products are widely and favorably known in the Dominican Republic, but at the present prices they are beyond the reach of the laboring classes. Lower prices would result in greatly increased consumption.

GUADELOUPE.

[By John S. Calvert, consul, September 24, 1921.]

Fish are caught for immediate sale and consumption in the waters surrounding Guadeloupe. They are never preserved and are not dried in commercial quantities. Imported dried fish are consumed. Refrigeration is not in use. No fish are found in the small rivers of the island. Fish obtainable in Guadeloupe resemble in variety and kind those usually found in West Indian waters. The best fishing

grounds are located between the main island and the small islands "Los Saintes," about 10 miles offshore, and the bulk of the fishing is done by the natives of those islands, who sell their wares at Basse Terre, Pointe-a-Pitre, and the other towns. However, small boats put out to make a catch from all the localities on the Caribbean side of the island practically every day that the weather is not too bad. Weather conditions on the Atlantic side are not favorable to fishing. However, the population there is very small.

Fishing is done both with hooks and lines and with nets, the latter being mostly used for catching inferior grades of fish near the shore. Bamboo traps are also used. The larger fish, those running from 5 to 20 pounds, are very good. The industry is not large, and the catch is entirely insufficient to furnish any large proportion of the diet of the mass of the population of 200,000. There are no exports of fishery products.

Fishery products, chiefly codfish, are one of the large items of the imports into Guadeloupe. Codfish is a staple article of food. Official statistics of imports by all countries and values are available only for the calendar year 1920. They do not indicate quantities, but with regard to kind it may be noted that it is all codfish, with the exception of about $20,000 worth of preserved fish imported from France. The table follows:

Imports of fishery products in 1920.

Country of origin.	Value in francs.	Value in United States currency at $0.069.
France	2,574,502	$177,640
French colonies (Martinique)	149,131	10,290
United States	947,265	65,351
British colonies	1,678,584	115,817
Total	5,349,482	369,098

The imports from France were of St. Pierre and Miquelon codfish, imported by way of France. There are, however, statistics available with respect to quantities and kinds imported during 1919 and 1920. Although the United States is grouped with the British colonies in these statistics, a rough calculation for the year 1920 gives 40 per cent to the United States and 60 per cent to British colonies.

Imports in 1919 and 1920.

Product and country of origin.	1919	1920
Codfish:	*Pounds.*	*Pounds.*
France	381,820	1,292,544
All other countries	1,956,098	1,584,545
Total	2,337,918	2,877,089
Preserved fish: France	54,745	79,491

The tremendous increase in the imports of St. Pierre and Miquelon codfish brought in by way of France, 1920 over 1919, will be noted. Assuming that the United States furnished 40 per cent of "all other" imports in 1920, or 633,818 pounds, it is found that the American

proportion has steadily declined since 1916, when imports from the United States were 1,531,522 pounds out of a total of 2,687,664 pounds. They were 895,478 pounds in 1917 and 720,000 pounds in 1918. It is necessary to note that during the war and extending through 1919 codfish were exempt from duty Before the war there were practically no imports of codfish from the United States.

Regarding preserved fish, statistics show that 54,745 pounds, valued at 159,332 francs ($22,761 at year's average of exchange) were imported in 1919, and 79,491 pounds, valued at 282,063 francs ($19,462 at year's average of exchange), were imported in 1920. Countries of origin are not given for 1919, but official statistics show that for 1920 all fish products classed as "preserved fish"—i. e., not salted or pickled in brine—came from France. It is highly probable that this is correct, and that no American tinned fish products were imported in 1920, due perhaps to the fact that the high exchange rates would make canned salmon much more costly than the excellent fresh fish obtainable locally.

American canned salmon was imported in limited quantities prior to that year, and it is noted that many retail dealers still have stocks on hand, which apparently do not move very readily, owing undoubtedly to the fact that it is offered for sale at prices based on the present exchange value of the franc, although most probably imported before the present severe depreciation of that currency. It is noted that none of this salmon is the third-grade whitish variety sold in such quantities in the Orient and in some tropical countries. It is practically all marked "red" and is of very good quality. Its retail price has dropped recently, and it is now sold at 3.50 francs for 1-pound can (at present exchange rate 47 cents). The best fresh fish is, however, 1.50 francs per pound, and the taste for salmon is not cultivated among those who could afford to pay the price.

The different kinds of fish preserved in cans have not been separated in import statistics since 1918. Even then sardines were the only item of sufficient importance to be so separated. A table of imports of sardines for several years follows:

Year.	Pounds.	Value in United States currency.	Year.	Pounds.	Value in United States currency.
1915	12,946	$2,193	1917	45,349	$8,616
1916	25,779	4,339	1918	15,770	7,660

During these four years the value of sardines imported from the United States was $219. Canned tunny-fish are imported from France to a limited extent. In 1915 fairly large quantities of herring began to be imported from the United States, but these imports have decreased, as the following figures show:

Year.	Pounds.	Value in United States currency.	Year.	Pounds.	Value in United States currency.
1915	237,457	$17,382	1917	306,088	$32,838
1916	273,605	26,871	1918	141,966	20,957

Separate statistics for 1919 and 1920 are not available. Salted fish prepared on the island of St. Martin are imported into Gaudeloupe but not in sufficient quantity to appear in statistics. There are no reexports of fishery products.

The opportunities to considerably extend the sale of American fishery products are not good. In the first place Guadeloupe is a low-wage country and its purchasing power is not great. In the second place, French colonial and French products are given the preference.

Codfish, the staple, is listed on the Guadeloupe special tariff, and the reduced custom rate, 10 francs a hundred kilos, is not great. However, it appears to have been sufficient during 1920 to have greatly increased the imports of St. Pierre and Miquelon codfish over American and British colonial competition.

With regard to canned salmon and sardines, as has been reported, there is no cultivation of taste for the first and no large importation of the second. Furthermore, French goods are duty free, while American goods are subject to the French general tariff.

Different prices are quoted for the several different kinds of codfish sold. The French codfish is graded as large fish and small fish, and now sells at wholesale at 2.40 francs ($0.192) and 1.90 francs ($0.152) per kilo, respectively. British colonies' codfish seems to be of one grade and wholesales at 2 francs ($0.16) per kilo. I can get no present quotations on American codfish but am reliably informed that the prices range above those for the better grade French. With regard to quality, it is reported to be superior to the other codfish.

Smoked herring are sold at wholesale, packed in wooden boxes weighing about 20 pounds and containing about 80 fish. The present quotation is 25 francs ($2) the box for the Canadian product. There seem to be no stocks of American herring at present.

Codfish, as has been stated, is a staple food of the mass of the people and is also generally used by the well-to-do. It is possible that low-grade salmon, if sufficiently cheap, may be sold to a certain extent in competition with it. This is also perhaps true with respect to cheap grades of sardines. French sardines are now sold here at an average of 1.50 francs (about $0.12) per small box containing 8 or 10 sardines about 3 inches long. The sardines are of very good quality.

MARTINIQUE.

FORT DE FRANCE.

[By Maurice P. Genton, vice consul, September 20, 1921.]

Like all the waters of the West Indies, those surrounding Martinique contain a great quantity and variety of fish, comprising kingfish, flying fish, garfish, mullet, mackerel, red snapper, grouper, sea-pike, sardines, catfish, swordfish, tuna, rays, sea eggs, spiny lobsters, crawfish, crabs, etc. The tuna is quite plentiful, and in 1918 there was talk of setting up a factory to can this fish for export, but the proposition never materialized. The fishing industry here is not organized, and all the fresh fish marketed is caught by negroes who go out to sea in their own rowboats with nets when they feel so inclined. As a result the quantity for sale each day is not nearly as large as it might be. If fishing were more regularly engaged in for-

eign fish would have to sell far below the prices at present obtainable, provided there were not the marked preference for dried cod which is mentioned below. Shellfish, such as clams and oysters, are practically unobtainable, and those found are of a very inferior quality. Most of the fishing is done with nets, lines being very little used, while spiny lobster, crawfish, crabs, etc., are caught in pots made of interwoven strips of bamboo.

There is no fish curing and no exportation of fish. Importations of fishery products include sardines preserved in oil, tomato sauce, etc., smoked and pickled herrings, pickled salmon, dried and salted cod, haddock, and hake. Sardines are usually imported from France, as they pay a lower duty than from foreign countries. Furthermore, olive oil, etc., is cheaper there than it is in some of the other countries. During the war, however, the bulk of all commodities imported into Martinique came from the United States. Smoked and pickled herrings are usually received from Canada and the United States, and sometimes from Barbados, where several of the large Canadian fish curers have agents to whom they ship on consignment. There are times when either the Barbados market is overstocked or the Martinique market is short of pickled herring, and in such cases it pays to order from the British islands. Pickled salmon is imported in but small quantities and is bought more often from Barbados rather than direct from the country of origin.

In the case of cod, haddock, and hake, comparatively large quantities are imported, considering the size of the island and its population of only about 200,000. A large part of these three kinds comes from St. Pierre and Miquelon and France, on consignment to two firms here that have the agencies of several French curers. This fish is the cheapest, pays a low rate of duty, and spares the purchaser the risks of exchange fluctuations, since it is bought in French currency. It can therefore undersell any foreign fish, making it highly attractive to buyers. It has, however, the disadvantage of being poorly cured, possibly not dried enough, and shipments which arrive in first-class condition are in a state of putrefaction shortly thereafter because of the total lack of cold-storage plants. Consequently, it is a decided risk to the small retailer who may be obliged to keep a cask of 448 pounds more than a month before he can dispose of it. This permits Canadian and Newfoundland fish to compete successfully, even though it always sells between 10 and 20 centimes more per kilo. There is at present only one firm which receives cargoes on consignment direct from Canada, but considerable quantities of this stock are imported from Barbados, which is only one day's distance by schooner from Martinique when the wind is favorable. An advantage in importing from that place is that shipments can be made immediately, thereby reducing to a minimum the risk of market fluctuations.

Practically no cod, haddock, or hake are received from the United States and what do come from there have usually been shipped from Canada via New York. The American fish has not met with success in Martinique, first because the quality supplied by the American shipper has been far too superior and consequently too expensive for the poor negro laborers, who earn but a few francs per day. The average fish from Canada are small fish, 12 to 18 inches long and not

very thick, that have dried rather dark instead of white as the fine quality received from the American shipper, but they are dry and stand the test of heat and dampness and keep well. This is the quality suitable for Martinique.

Another factor which hampers the American shipper is that he never gets an order large enough to load a schooner. The freight which the purchaser here is obliged to pay is therefore much higher and increases his cost. Exchange is also an important factor. As matters now stand the Canadian supplier benefits by approximately 15 per cent on exchange alone, which gives him a decided advantage over his American competitor.

BARBADOS.

[By John J. C. Watson, consul, September 21, 1921.]

The principal local fishery products are flying fish, red snappers, and whale oil. The fish are sold fresh, and no canning or pickling is done. Whales used to be plentiful in these waters, but only one or two are now caught during the course of a year. Fishing is done in small boats with hooks and lines. Whales are killed by the use of darting guns and shoulder guns, fired from boats. Each boat is manned by 14 men. No fish are cured locally, and no fishery products are exported.

Fresh, pickled, preserved, salt, and smoked fish are imported into this colony. The countries of origin, quantity, and value of each kind, according to the latest statistics, are as follows:

Product and country of origin.	Barrels.[1]	Value.	Product and country of origin.	Barrels.[1]	Value.
Fresh fish:			Preserved fish:		
Trinidad		$1,849	Great Britain		$1,503
United States		26,600	Canada		8,759
Total		28,449	Total		10,262
Pickled fish:			Salted and smoked fish:	*Quintals.*[2]	*Value.*
Canada	5,265	57,633	Great Britain	2,240	24,527
Newfoundland	2,544	27,855	Canada	14,348	157,109
British Guiana	120	1,519	Newfoundland	54,911	601,256
United States	664	7,265	Bermuda	48	525
Total	8,593	122,721	United States	1,104	5,372
			Total	72,651	788,789

[1] The barrel weighs 200 pounds.

[2] The quintal weighs 112 pounds.

A small quantity of the fishery products is reexported to the other West Indian Islands. In 1919, the latest year for which statistics are available, 37,713 quintals of salt fish and 2,443 barrels of pickled fish were reexported.

Most of the fishery products used here are imported from British countries. The reasons for this are the preferential duty and the hard cure, which keeps better. American fresh fish competes successfully with fish from British countries, because fresh fish is free. If American manufacturers desire to compete with British manufactures, they should hard cure their fish and put them up as follows:

Pickled fish in 200-pound barrels, preserved fish in 1-pound tins, salt fish in 112-pound drums, and smoked fish in 12 to 28 pound boxes.

TRINIDAD.

[By Henry D. Baker, consul, September 5, 1921.]

The waters about the coast of the islands of Trinidad and Tobago are noted for abundance of fish, especially around the Bocas Islands in the straits between the northwestern part of Trinidad and the Venezuelan mainland and connecting the Caribbean sea with the Gulf of Paria. The Island of Chacachacare is the center of the local fishing industry around surrounding small islands and banks.

A well-known local work on "The Sea Fish of Trinidad," by Harry Vincent, gives a classified list of 85 species of food fishes and 31 species not used for food. Of the food fishes 15 are ranked as of superior quality, 34 of good quality, and 36 of inferior quality. The fish of superior quality include the following:

Trinidad name.	Scientific name.	Habitat and means of catching.
Red mouth grunt	Hæmulidæ (the grunts)	Rocky bottom; with cast lines or sinkers, also fish pots.
Pargue (dentchien)	Lutianus jocu	Rocky bottoms; with cast line or lines dormant.
Sorb	Lutianus analis	Do.
Vivanot jolle-bleu	Lutianus aza	Deep-sea bottom fishing; rocks or mud.
Red grouper	Epinephelus morio	Rocky bottom; with line dormant or bottom fishing.
Tassard or kingfish	Scomberomorus cavalla	Rocks or mud; trolling and occasionally in seines.
Carangue grasse	Caranx crysos	Trolling or in seines; rocky bottoms chiefly.
Carangue a plume	Nematistrus pectoralis	Trolling and bottom fishing; rare; rocky bottoms.
Pompano	Trachinotus goodei	Cast line or harpoon.
Coolihoo or jackfish	Caranx bartholomæi	When small, in seines; large, on hook; bottom fishing.
Codfish or morue	Gadus morrhua	Trolling and harpoon; very rare.
Lebranch or mullet	Mugil brasiliensis	In mullet nets; will not take hook; mud banks and estuaries.
Ancho	Mugil trichodon	Mud banks; in seines; seldom by hook.
Black doctor fish or tang	Teuthis hepatus	Rocky bottom; fish pots; will not take hook; good food.
Aileronde	Achirus lineatus	Harpoon, seine, and rarely hook; sandy shores.

In the vicinity of the Bocas Islands during the months of June, July, and August the fishermen frequently catch in their seines schools of fish ranging from 10, 000 to 20,000 pounds' weight, chiefly "cavalli" and "paoua," considered of good but not superior class of local fish. These can be kept alive for some days in the seine, hauling the ends ashore and mooring the back of the bag or purse to a boat anchored out. Apparently the Bocas fishing grounds would be impracticable for trawling on account of the rocky bottom and reefs. Nevertheless, in the Gulf of Paria and in other adjacent waters there would seem to be good opportunities for steam trawling not now availed of. The local supply of sea food at present is dependent upon irregular efforts of fishermen and not upon any well-organized industry with sufficient capital and equipment. The kingfish, mackerel, and jackfish of Trinidad might be salted and cured to considerable advantage, but this is not done here, although such cured fish is produced in Venezuela and sent here.

The average daily consumption of fresh fish in Port of Spain, the leading town of Trinidad, is approximately 5,000 pounds, or about 1 pound for every 10 persons. Such consumption of fresh fish seems very small, considering the plentiful supply as well as excellent quality of fish in surrounding waters. In competition, however, with beef from Venezuela and salt fish from Canada, the local fresh fish is usually higher in price, due to lack of sufficient organization and equipment in the industry. At present fresh fish in the Port of Spain market sells for 18 cents per pound, while beef from cattle brought down the Orinoco River in Ciudad Bolivar, Venezuela, sells for only 15 cents per pound, and salted cod from Canada for 14 cents per pound.

Salt cod from Canada is one of the most staple articles of diet in this colony. The imports of fish of all kinds from Canada, but including chiefly salt cod, amounted to $688,195 in 1919 as compared with $438,369 in 1918 and $472,195 in 1917. The imports of fish from the United States include chiefly canned salmon and to a less extent canned lobsters, shrimp, oysters, etc. The total value of fish imported from the United States in 1919 was $13,185. American canned fish is always in better demand in the local market than the canned fish of other countries, except that a few specialties, such as sardines, are supplied from France, Spain, Portugal, and Norway.

There is considerable local consumption of a small variety of oysters, which grow on mangrove trees under tide level along the coast of the Gulf of Paria. Shrimp are also plentiful. Large numbers of turtles are sold locally. These make an excellent soup, which is one of the favorite dishes of the West Indies, and turtle fins and turtle cutlets also have an important place in West Indian cooking.

No fish is exported from Trinidad, except such imported fish as may be distributed from here to neighboring West Indian Islands or to Venezuela.

CURACAO.

[By B. S. Rairden, consul, September 5, 1921.]

In the district of Curacao, with a population of less than 35,000, the fishing industry is of little importance, and deep-sea fishing is carried on by perhaps 20 fishing boats of from 3 to 5 tons each and quite a fleet of small "canoes" catching sufficient to meet the local demands but not sufficient for export.

The larger fishing boats, leaving the harbor before daylight, fish by lines and nets, the larger fish being caught by lines and the smaller in nets. The boats generally return before dark and dispose of their catch to fish dealers, who make their purchases from the boats. The fish caught are the usual tropical sea fish, such as bass, dolphin, mullet, and many for which names are not known and many which are considered poor food. The "canoe" fishing is done entirely with lines; small fish are generally caught and disposed of in the smaller harbors along the coast of the island. Much of the fish caught is salted and sold locally in the markets after being cured. It can be said that none of the fish supply is exported, except what is sold to the vessels in the harbor. Such fish sold amounts to about $1,000 per year for the fresh product and $1,600 per year for the salted fish.

The importation of salt-cured fish into Curacao amounts to about $7,000 annually, imported entirely from Venezuela, and business in salt codfish, amounting to $3,600 annually, is done almost entirely with the United States. So far as known no imported fishery products are reexported.

Statistics of canned goods imported do not specify the different kinds of articles under this heading. The total value of canned goods imported for the past year amounted to $114,000, $86,000 worth of which came from the United States. Such goods imported from the United States are fish, fruits, and meats, while most of the canned goods coming from Europe and Great Britain, mainly from Holland, are vegetables. France and Spain, it is reputed, have the bulk of the business in sardines. Dried (salt) codfish is imported principally from the United States, and the bulk of the food products imported are also from the American market.

At the present time the high rate of exchange prevents an increase in American imports, but the importers are favorably inclined toward American business, and it is believed in time such business will show up well in this colony. Many of the merchants in this district have good connections with American firms and are waiting a more favorable exchange to renew business in American goods. In the meantime I would strongly advise our exporters to send their representatives through the West Indies and South American countries to endeavor to make further good business connections and compete with the slowly increasing German trade.

JAMAICA.

KINGSTON.

[By William W. Heard, vice consul, December 8, 1921.]

The Island of Jamaica depends almost entirely on outside sources for fish and fish products. Slight activity is evidenced in catching fish for local consumption, and this effort is so haphazard that a plentiful supply of fresh fish in the important coast towns, such as Kingston, Port Antonio, and Montego Bay, is a rarity. The fishing around Kingston has been carried on in such a ruthless manner that few fish, if any, are left in the waters forming the harbor, an area of approximately 26 square miles. It is therefore safe to say that there is no fishing industry in Jamaica.

The following table shows the imports of quantities and values of the different kinds of fish imported into Jamaica for the half year ending June 30, 1921; conversions made at $4 to the pound sterling.

Product imported.	Quantity.	Value.	Product imported.	Quantity.	Value.
Alewives...............barrels..	2,158	$20,344	Pickled, not specified..pounds..	4,018	$200
Dried, salted fish.....pounds..	4,796,452	484,188	Salmon, pickled........barrels..	179	1,100
Herring, pickled........barrels..	15,410	128,488	Salmon, smoked........pounds..	26	8
Herring, smoked......pounds..	76,841	9,528			
Mackerel, pickled......barrels..	3,092	60,160	Total......................	....	704,016

The greatest demand is for salt fish. This is usually packed in tierces containing 450 pounds and consists of three grades—bank

fish or prime bank, prime shore, and extra dry fish. The last is the best quality. The next in importance is pickled fish. This is packed in barrels containing 200 pounds and is of three kinds—herring, alewives, and mackerel. The herring range in weight from 4 to 16 ounces, the mackerel, from 12 to 24 ounces. At least 80 per cent of all the fish imported into this island comes from Canada, and the remainder, about equally divided, comes from the United States and Newfoundland. The Canadian fish has been able to hold this market, as the product is good, the price right, and the dealers have become accustomed to handle certain recognized brands that have satisfied their customers. It is considered doubtful whether this trade can be turned to any other country, especially in view of the fact that the Canadian fish will soon have a preferential of 25 per cent over fish from other countries.

BERMUDAS.

HAMILTON.

[By Albert W. Swalm, consul, January 20, 1922.]

Although the waters surrounding the Bermuda Islands abound in fish of many varieties, there is little fishing, and for at least one-half of the year it is impossible for residents of the islands to secure fresh fish to supply their tables. During the summer months when the sea is calm there is a bountiful supply of fish, as fishing may be done from small boats and great catches had, but during the winter season small boats can not live in the open sea and there is no fishing. The local demand does not justify the expense of larger boats. There are no factories nor fish-curing plants, so year after year the residents of the islands have fresh fish only during the summer months, while during the winter months, when the islands are filled with tourists, there are periods of several days when no fish are to be had.

Fresh salmon, mackerel, and other fish are imported from Canada during the winter months, and all preserved and tinned fish are imported from England, Canada, and the United States. Records kept by the customs' officials do not give the amount of tinned fish, as they come under the general head of "tinned goods." Preserved fish in the following quantities were imported during 1920: From England, 587 packages, valued at $7,820; from United States, 1,283 packages, valued at $14,670; and from Canada, 6,686 packages, valued at $64,150. Local grocers state that much of the tinned fish comes from the United States, as supplies of this nature are in most instances bought from wholesale grocers in New York.

ENSENADA
MEXICALI
CIUDAD JUAREZ
HAMILTON
GUAYMAS
CHIHUAHUA
PIEDRAS NEGRAS
NUEVO LAREDO
MONTERREY
MATAMOROS
GULF OF MEXICO
MAZATLAN
AGUASCALIENTES
MEXICO
GUADALAJARA
MEXICO CITY
MANZANILLO
VERA CRUZ
PROGRESO
HAVANA
MATANZAS
NUEVA GERONA
CIENFUEGOS
ANTILLA
CAPE HAITIEN
PUERTO PLATA
SANTIAGO
JAMAICA
KINGSTON
PORT AU PRINCE
SANTO DOMINGO
FRONTERA
PUERTO CORTEZ
LA CEIBA
ACAPULCO
SALINA CRUZ
GUATEMALA
GUATEMALA CITY
HONDURAS
SAN SALVADOR
CORINTO
NICARAGUA
BLUEFIELDS
CENTRAL AMERICA
COSTA RICA
SAN JOSE
LIMON
COLON
PANAMA
GUADELOUPE
FORT DE FRANCE
MARTINIQUE
BARBADOS
CARIBBEAN SEA
SANTA MARTA
BARRANQUILLA
CARTAGENA
CURACAO
PUERTO CABELLO
LA GUAIRA
TRINIDAD
MARACAIBO
VENEZUELA
GEORGETOWN
BRITISH GUIANA
DUTCH GUIANA
FRENCH GUIANA
COLOMBIA
PARA
PERNAMBUCO
ECUADOR
GUAYAQUIL
SOUTH AMERICA
BRAZIL
PERU
CALLAO-LIMA
BAHIA
BOLIVIA
IQUIQUE
ANTOFAGASTA
PARAGUAY
ASUNCION
SAO PAULO
RIO DE JANEIRO
PORTO ALEGRE
ARGENTINA
CHILE
VALPARAISO
CONCEPCION
URUGUAY
BUENOS AIRES
MONTEVIDEO
PACIFIC OCEAN
ATLANTIC OCEAN
PUNTA ARENAS

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FISHERY INDUSTRIES OF THE UNITED STATES.

REPORT OF THE DIVISION OF FISHERY INDUSTRIES FOR 1921.[1]

By Lewis Radcliffe, *Assistant in Charge.*

CONTENTS.

[1] Appendix IX to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. 932.

INTRODUCTION.

The very threatening situation confronting the fishery industries in 1920 continued throughout 1921, with slight indications of improvement late in the year. As a result there was further curtailment in the production of important fisheries and retrenchment in operations. In the New England vessel fisheries centering at Boston and Gloucester, Mass., and Portland, Me., the decrease in production in 1921 as compared with 1920 amounted to 27,415,595 pounds in quantity and $2,504,384 in value, a decrease since 1918 in excess of 54,000,000 pounds in quantity and $4,750,000 in value. The average price per pound received for these fish in 1916 was 3.44 cents; in 1918, 5.12 cents; in 1920, 4.61 cents; and in 1921, 3.79 cents. The pack of sardines in Maine in 1919 was 2,450,268 cases, valued at $11,933,986; in 1920, 1,877,757 cases, valued at $7,435,056; and in 1921, 1,350,631 cases, valued at $3,960,916. Such well-known fishes as red snappers taken in the fisheries of the Gulf of Mexico were marketed with difficulty and considerable quantities sold on consignment at less than the cost of production. In Alaska the pack of salmon in 1918 was 6,605,835 cases, valued at $51,041,949; in 1920, 4,429,463 cases, valued at $35,602,800; in 1921, 2,596,826 cases, valued at $19,632,744. In 1920 the pack of sardines in California exceeded 1,000,000 cases, with a value of nearly $3,000,000, and in 1921 it amounted to 415,587 cases, valued at $2,346,446.

Post-war readjustments have compelled a closer study to be made of costs of operation and means of effecting economies in operation. This is reflected in the increased demand upon the bureau for the service this division performs, particularly in the fields of statistics, technology, and merchandising. The increase in the division's appropriation beginning with July 1, 1921, has made possible an enlarged program of operations, and a number of investigations which promise to yield important practical results have been initiated.

SUMMARY OF OPERATIONS.

During the year statistical canvasses were made of the fisheries of Maryland and Virginia for 1920, of the take of shad and alewives in the same States during the fishing season of 1921, and of the canning and by-products industries of the United States in 1921. The last was confined to the number of plants operated, the raw products utilized, and the quantity and value of the finished products. The landings of the vessel fisheries at the ports of Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., have been collected as heretofore and published as monthly and annual bulletins. The results of these canvasses are embodied in the present report, together with a summary of the cold-storage holdings of frozen fish in 1921 and quantities frozen; the quantity of fishery products taken in California in 1921, shown by species and by months; the fishery products received at the Municipal Fish Wharf and Market, Washington, D. C.; the shad and alewife fishery of the Potomac River in 1921; and certain sponge statistics.

In fisheries technology noteworthy progress has been made in the fields of net preservation and brine freezing of fish, and in the methods of canning such fishery products as sardines. In June there was

begun a series of market surveys, which has included the following centers: Louisville, Ky.; Pittsburgh, Pa.; Chicago, Ill.; and Minneapolis and St. Paul, Minn. The division has continued to aid in increasing the use of by-products of the fisheries, in increasing the use of fish as food, and in effecting improvements in the merchandising of fishery products and the methods of capture and has prepared for publication, for the use of those interested therein, the results of work completed.

PUBLICATIONS OF THE DIVISION.

During the calendar year 1921 the following publications, prepared in this division, were issued. This list does not include the monthly statistical bulletins for Boston and Gloucester, Mass.; Portland, Me.; and Seattle, Wash.

DOCUMENTS.

Preservation of fish nets, by Harden F. Taylor, 8°, 35 p., 1 text fig., Document No. 898.

Improvements in process of salting river herring, especially adapted to warm climates, by Harden F. Taylor, 7 p., Document No. 903.

Fishery industries of the United States. Report of the division of statistics and methods of the fisheries for 1920, by Lewis Radcliffe, 8°, 187 p., 9 figs., Document No. 908.

ECONOMIC CIRCULARS.

Trade in fresh and frozen fishery products and related marketing considerations in Louisville, Ky., by L. T. Hopkinson. 8°, 8 p., Economic Circular No. 50.

Trade in fresh and frozen fishery products and related marketing considerations in Pittsburgh, Pa., by L. T. Hopkinson. 8°, 9 p., Economic Circular No. 52.

Brine freezing of fish, by Harden F. Taylor. 8°, 8 p., Economic Circular No. 53.

Trade in fresh and frozen fishery products and related marketing considerations in Chicago, Ill., by L. T. Hopkinson. 8°, 21 p., Economic Circular No. 54.

STATISTICAL BULLETINS.

Statement, by fishing grounds and by months, of quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels during the calendar year 1920. Statistical Bulletin No. 487.

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Statement by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American and Canadian fishing vessels during the calendar year 1920. Statistical Bulletin No. 489.

Fisheries of the South Atlantic States, 1918. Statistical Bulletin No. 494.

Fisheries of the New England States in 1919. Statistical Bulletin No. 497.

NOTES ON FISHERY APPARATUS.

SWEEP NET OR SEINE.

In view of the widespread interest aroused by the introduction of the Danish sweep net or seine (snurrevaad) in the British fisheries, the following notes on operation and construction may be of interest to American fishermen as well. In construction the sweep net is similar to the otter trawl, but it is smaller and less expensive and can be operated by smaller vessels at less expense. In operation one end of the warp is attached to a buoy held in position by an anchor while the vessel follows a circular course laying the net across the tide, bringing the two ends of the warp together at the buoy. The

vessel is anchored, the two ends of the warp are passed through the rope rollers onto a winch, and the net hauled in directly against the tide.

There are two different types of these nets—the plaice net and the haddock net. The first is the type for flat fish and the second for round fish; the size of mesh in each is therefore slightly different. Both these types are carried on each vessel. The total length of the net is from 33 to 36 fathoms, the depth from 6 to 7 fathoms, and the length of each warp from 750 to 1,000 fathoms according to the depth of water. In the plaice net the size of mesh in the wings is 2-inch bar and the cod end 1½-inch bar. In the haddock net the size of mesh in the wings is 2½-inch bar and in the cod end 1¼-inch bar. The wings are 16 fathoms and the center 4 fathoms in length.

The cod end is of double cotton mesh. The head and foot ropes are of hemp 1½ inches in circumference, and the net is of cotton. The whole net is of very light construction. The warp is 2½ inches in circumference and may be of English manila, Danish manila, Danish sisal, etc. The head line is provided with either cork floats or glass bulbs to keep the net upright; the footrope is weighted with lead sinkers, slightly heavier in the center. The floats and sinkers are adjusted so that the net just touches the bottom, though with the plaice net it is necessary to drag to a certain extent along the bottom. In some cases pieces of chain about 2 feet in length are attached to the ground rope for "tickling," an ash stick 6 feet in length is seized on either end of the net to assist in keeping it open, and to this stick the warp is attached, but this is not universally used. The length of the cod end is about 9 fathoms. The cost of the haddock net (1921) was about $121 and of the plaice net $73.

The ship's anchor, with the warp attached, is dropped and buoyed. The ship then steams about two points off the tide; that is, with the tide setting north, the ship steams NNE. or NNW., paying out warp as she goes. After paying out about 600 fathoms or more, according to depth, the ship turns so as to lay the last 100 fathoms of warp, the net, and a further 100 fathoms of warp, across the tide, when she turns again to pick up her moorings, paying out warp at a sufficient speed to prevent any drag on the net. When fast to her moorings, both warps are attached to a special winch and are hauled in together. When hauling, the warps act as "ticklers" and drive the fish into the net. The fact that the warps remain on the bottom keeps the net open till within 50 fathoms of the ship. The whole process of shooting and hauling is said to take less than an hour. The fish are all taken alive and are in first-class condition. The boats used vary in size from the small motor boat of about 10 tons to the small steam trawler of about 90 to 100 tons, though the most suitable seem to be wooden drifters of about 45 net tons.

It is believed that this type of fishing can be carried on only in fine weather and can not be regarded as a whole-time method. Several skippers, however, who are using this net claim that with proper care it can be used all the year. The majority of vessels fitting with this type of gear propose to take up line fishing during the winter months, and vessels are chosen with a view to being suitable for either purpose. A steam trawler which burns about 5½ tons of coal per day when trawling is said to burn only 2 to 2½ tons per day when seining, although the catches have been about equal.

This net was formerly manufactured exclusively by the Danes. Recently (1921) the demand has been so great that the nets have been made in sections at Bridgeport, Dorset, and sent to Esbjerg to be completed. The cotton used is of a special kind and comes from a firm in Manchester. One difficulty in the use of this net has been that those who use it have been unable to obtain the particular kind of cotton needed for mending purposes, and in some cases when the net is badly damaged have had to send it to Esbjerg for repairs, where this particular kind of cotton is obtainable. It is now being manufactured in England.

A special winch and coiler are used for this net. Until recently these have been manufactured exclusively in Denmark, but the English concerns are now manufacturing them and improving upon their construction. The price of the winch at present (1921) is $583 and of the coiler $124. A special point about the winch is that both warps are brought through a fair lead and three turns are taken around each drum; thence the warp is taken over a small drum and passed through an aperture, one side of which has a concave wheel and the other a cog wheel, which holds the warp tight by a spring. When the winch is set in motion, the coiler is actuated by a chain belt, and underneath is a circular metal rotary hopper which coils each warp into a neat coil as it revolves. The drum of the winch can be worked together or separately, so that if any obstruction occurs with one warp the whole net can be hauled in by using the other warp only. Mistakes have frequently been made by putting more than three turns of warp around the drums, for if any obstruction occurs instead of the warp slipping it parts with the strain, and the net is liable to be lost. The winch is placed just forward of the wheelhouse. Part of the fish hold is roofed over with wooden drifters to accommodate it. Experiments are being made to place an iron bedplate underneath the winch to strengthen its construction.

CRAWFISH FISHERY OF WISCONSIN.

In the Green Bay district of Wisconsin there is a small fishery for crawfish which, with the development of more extended markets, is capable of some expansion. In 1899 the catch of crawfish in this region amounted to 135,861 pounds, valued at $3,498; in 1903, 244,464 pounds, valued at $7,897; and in 1917, 80,495 pounds, valued at $4,427, the catch being limited to market demands.

The fishery is conducted from July to November, shipments being made principally from Green Bay, West De Pere, Sturgeon Bay, and Little Suamico to points as far east as Cleveland and New York, and as far west as Omaha, Kansas City, St. Louis, and Leavenworth. The principal markets are Chicago, Milwaukee, Omaha, and New York. Shipment is usually made in baskets or small boxes of various sizes, carrying 200 to 500 crawfish. In the warmer months crushed ice and sawdust are included in a compartment of the package during periods of high temperature or for long-distance shipment.

An ingenious pot (Fig. 1) is used to capture the crawfish. Following is a description of one of these pots: Four sides equal, 16 by $8\frac{3}{4}$ inches, of $1\frac{1}{2}$-inch lath, four laths to a side; ends square, each with a four-sided funnel that has an exterior aperture $4\frac{1}{2}$ inches square and a mouth about $1\frac{1}{2}$ by 1 inch, with the upper board projecting over the mouth about $\frac{3}{4}$ inch; lower ends each with a triangular cement block,

fitted around the funnel and extended upward to the middle of the end, to sink and hold the trap on the bottom; top removable, with a wire hook projecting downward from center of top, on which the bait

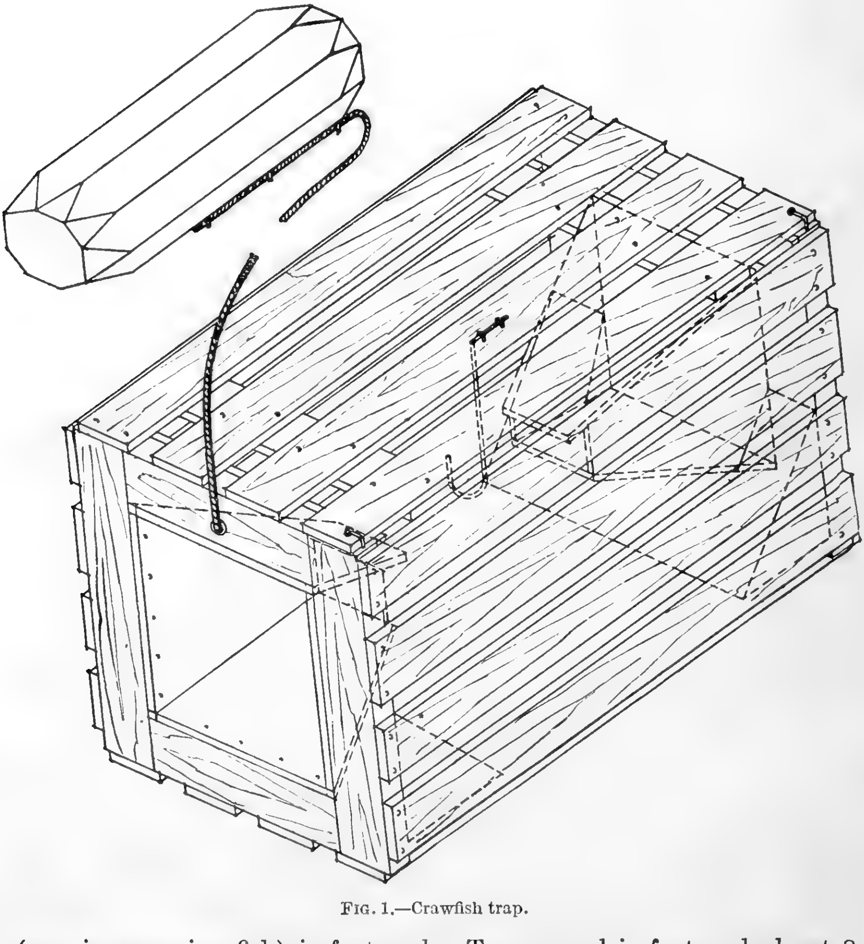

FIG. 1.—Crawfish trap.

(any inexpensive fish) is fastened. To one end is fastened about 8 feet of $\frac{3}{8}$-inch rope with a short wooden float at the free end.

IMPROVEMENTS IN MERCHANDISING FISHERY PRODUCTS.

The bureau realizes the importance of rendering all possible assistance in effecting improvements in fish merchandising and has aided as fully as practicable those seeking such assistance. It is hoped that provision may be made for more extensive aid in this field. There is special need for the assemblage of specific information on such subjects as the losses through shrinkage in the handling of fresh fish and its preparation for the consumer, in both the fresh and preserved state. Many factors need consideration, such as the losses through evaporation under varying conditions, the shrinkage factors for each

of the species of commercial importance, etc. What are the losses in weight in freezing, salting, drying, skinning, boning, pickling, smoking, and canning? These are items that enter into costs regarding which the trade should have definite information if it is to operate efficiently, and members of the trade have emphasized the fact that to realize the greatest good from such work it should be conducted by a Federal agency such as the Bureau of Fisheries. The following illustrates one of the bureau's efforts to render service in this field:

IMPROVEMENT IN TRANSPORTING SEA CRAWFISH.

About 40 per cent of the sea crawfish or spiny lobsters shipped from points in Florida to the Washington (D. C.) markets formerly arrived dead, resulting in heavy losses to the express carriers. At a conference with a representative of the carriers it was learned that the crawfish were packed in alternate layers of ice. The bureau suggested changes in this method of packing which were carried out and have reduced the losses to about 2 per cent, eliminating all claims against the carrier, except for packages lost in transit. The improved method of packing follows: Inside the ordinary large lobster tub is placed a smaller tub, the bottoms of the two being fastened together. The lobsters are packed in the smaller container in even layers to within about 6 inches from the top, and the balance of the space is filled with sponge scraps or seaweed and covered with a slatted top, securely fastened. On top of this tub is placed a chunk of ice of sufficient size to last until shipment reaches destination, and the top of the outer container is covered with matting or burlap. If reicing is necessary it is a simple matter to remove cover of outer container and put in more ice. This method of packing keeps the spiny lobsters from actual contact with ice, avoiding the abrupt change in temperature, and the melting ice dripping down through the layer of sponge scraps or seaweed keeps them moist and cool.

MARKET SURVEYS.

There is a dearth of information on the subject of fish marketing without which progress in effecting improvements in the methods of handling and distribution of fishery products, in intelligently combating the prejudices of the consumer, in increasing the consumption of fish, and in educating the public to the proper place of fish in its dietary, must be slow and extremely costly. For several years the bureau has been desirous of contributing to this phase of the fisheries but has lacked both funds and workers properly equipped for such an undertaking. In June, 1921, a survey of Louisville, Ky., was made, followed by surveys of Pittsburgh, Pa.; Chicago, Ill.; and Minneapolis and St. Paul, Minn., all of which were completed before the end of the calendar year. (See List of Publications, p. 3.)

These surveys have been confined to the trade in fresh and frozen fishery products and include such subjects as composition of population, sources of supply, trade names in use, grouping of species into those on which the bulk of the trade is based, those of moderate importance, and those for which the sale is small, character of containers, cold-storage holdings, carload freight and express arrivals, short-line travel distances and freight and express rates from principal sources of supply, wholesale and retail trade, including directory of dealers, and advertising and display.

The trade has evinced a deep interest in these reports which have been distributed as far as practicable to those persons who will make the best use of them, the edition, limited by law, being inadequate for distribution to all in the trade, to those on regular mailing lists, and to inquirers. The following tables based on these reports are given for comparative purposes:

SUMMARY OF MARKET SURVEYS FOR FISHERY PRODUCTS IN CERTAIN CITIES.

Items.	Louisville.	Pittsburgh.	Chicago.	Twin Cities.
Population	234,891	588,343	2,701,705	615,280
Ratio of dealers retailing sea foods to population	1 : 16,778	[1] 1 : 8,914	1 : 16,275	1 : 16,629
Number of species:				
Handled	37	70	82	59
On which bulk of trade is based	[2] 6	[2] 8	[3] 11	[4] 8
Of moderate importance	5	7	13	6
For which sale is small	26	55	58	45
For which following reasons explain slight sale—				
Supply limited	5	11	18	4
Unpopular	10	21	13	9
Prices too high	9	7	1	11
Sold chiefly to foreigners	......	9	5	3
Sold chiefly to hotels and restaurants	......	1	7	2
Principal containers and capacity:				
Boxes ... pounds	100	100, 150, 200, 300	100, 150, 200, 300	100, 150, 200, 300
Barrels ... do	200	......	......	......
Number of carload arrivals during 12-month period:				
By freight	45	67	470	84
By express	......	......	523	2
Partial unloading	......	......	422	186
Number of sea-food dealers [5]	14	71	222	48
Wholesale exclusively	......	5	56	11
Wholesale and retail	2	6	18	5
Retail only	12	60	148	32
Retailing fresh fish	14	59	165	36
Also handling—				
Frozen fish	10	50	157	33
Oysters	12	59	131	28
Other shellfish	3	25	126	25
Salted fish	2	38	120	25
Smoked fish	......	42	126	28
Canned fish	......	34	88	22
Poultry	4	38	7	29
Meats	......	20	6	30
Groceries	1	30	25	10

[1] The apparent explanation of this low ratio is that there are few butchers or grocers handling fresh and frozen fish as a side line.
[2] 75 per cent. [3] 70 per cent. [4] 90 per cent.
[5] Exclusive of butchers, grocers, delicatessen stores, etc., that handle fish as a side line, of which there are large numbers in Louisville, Chicago, and the Twin Cities.

IMPORTANT AND SECONDARY COMMERCIAL SPECIES OF FISH IN CERTAIN CITIES.

[I, important commercial species; S, species of secondary importance. Important commercial species represent 70 to 90 per cent of the sales.]

Species.	Louisville.	Pittsburgh.	Chicago.	Twin Cities.	Species.	Louisville.	Pittsburgh.	Chicago.	Twin Cities.
Buffalofish	I	......	I	S	Red snapper	......	......	S	......
Bullheads	......	......	S	S	Sablefish	......	......	......	S
Carp	I	......	I	S	Salmon	......	S	I	I
Catfish	I	......	S	......	Smelt	......	S	......	......
Ciscoes	I	I	I	I	Spanish mackerel	S	......	......	......
Cod	......	I	S	......	Suckers	......	......	S	......
Crappie	......	......	......	S	Sunfish	......	......	......	S
Haddock	......	......	S	......	Tullibee	......	......	S	......
Halibut	S	I	I	I	Whitefish	......	I	I	I
Lake trout	S	......	I	I	Yellow perch	......	S	I	......
Pike or pickerel	......	......	I	I	Oysters	S	I	I	I
Pike perches:					Hard clams	......	S	S	......
Blue pike	I	I	S	......	Shrimp	......	S	S	......
Sauger	I	I	S	......	Turtles	......	S	......	......
Yellow pike	S	I	I	I					

The trade will find the comments on methods of display, extent of advertising of fishery products, city health ordinances governing the sale of same, regulations governing the cold storage of fish, the tables of short-line travel distance and freight and express rates on fresh and frozen fish from principal sources of supply, the sources of supply, etc., of particular interest.

INCREASING THE USE OF FISH AS FOOD.

Lacking special provision for operations in this field and a trained personnel essential to the success of such work, the activities of the bureau have been limited. The series of market surveys now in progress are supplying data of marked value for future operations.

PINK AND CHUM SALMON.

With large holdings of canned salmon at the beginning of the year, the salmon interests inaugurated an extensive advertising campaign to increase the consumption of this excellent food and requested the bureau to lend assistance. Holdings of the cheaper grades, pink and chum salmon, were at the time offered for sale at unusually low prices, furnishing the consumer with one of the lowest-priced protein foods on the market. To aid in increasing the consumption of these products, the bureau issued attractive posters and an economic circular from which the following is an extract:

> Pinks and chums usually contain less fat but are equal to the redder varieties in protein—tissue-building material. They are low priced because of their abundance and the use of labor-saving machinery in handling and canning them. Their high protein content and lower cost render them more economical than most animal foods in common use.[2]

NATIONAL FISH DAY.

For several years Canada has observed the first day of Lent as National Fish Day, and the plan is reported to have proved "a very successful means of stimulating interest in the fishing industry and in increasing home consumption." A similar move was initiated in the United States, March 9, 1921, being observed. This move on the part of the trade received the hearty support of the Secretary of Commerce and was given all possible aid by the Bureau of Fisheries. While the period within which preparations had to be made was exceedingly short, the observance of the day is reported to have markedly stimulated sales of fish and interest in the industry.

FISHERY CONFERENCES.

The conferences of representative men of the fishery industries called by the Secretary of Commerce during the year have developed a clearer understanding on the part of the trade of the important problems falling within the scope of the bureau that need attention and of the limitations beyond which it can not go. The first of these conferences, attended by representatives of the fresh, frozen, salt, and canned fishery industries, including the oyster, crab, shrimp, and menhaden fisheries from the Atlantic and Gulf coasts, the Great Lakes, and the Mississippi Valley, was held at the Department of

[2] Canned Salmon: Pink and Chum. Economic Circular No. 48, issued Feb. 16, 1921.

Commerce on May 9 and 10, 1921. The following committees were formed and have submitted reports: Transportation; education; fresh and frozen fish production and distribution; salt and canned fish trades; oyster, crab, and shrimp trades; fertilizer and feed industries; and pollution and Federal and State Control of fisheries.

Among the recommendations made that bear particularly on the division's work were the following: Importance of insuring catches of unquestioned freshness; avoidance of mutilation by the use of forks or pews and otherwise; careful packing for shipment in the most approved type of containers with adequate icing; importance of prompt shipment after landing to the nearest central market; cooperation with the bureau to secure improvements in freezing and preparation for distribution, including a thorough investigation of the possibilities of the new brine-freezing methods and the publication to the fishermen of the results of the investigations; education of and cooperation with the wholesaler and retailer, including the exercise of care in handling and storing of stock and its sale amid sanitary conditions; employment of improved trade practices in order to determine the essentials of a model fish market and to develop more even distribution of sales throughout the week; education of the consuming public to remove prejudices, to promote more intelligent buying, to secure a better understanding of the importance and place of fish in its dietary and recognition of seasonal variation in abundance; establishment and maintenance of standards of quality and containers for preserved products; and development of foreign fish trade.

With respect to by-products of the fisheries, recommendations included an investigation by experts of the various and contradictory methods of manufacture in producing fish scrap, meal, and oil, with a view to (*a*) standardization of those processes that insure the best product at the lowest cost and (*b*) equipping the industry to withstand foreign competition; a market survey for the expansion and development of new markets for the products of the industry, including investigations to reveal the suitability of products to present uses, development of improvements, new products, and increased use for products now manufactured, such as the advantages of fish oil in the manufacture of paints.

During the year the problems of fish merchandising and refrigeration, including brine freezing, have received special consideration by the division.

TECHNOLOGICAL INVESTIGATIONS.

Under conditions obtaining during the past few years the need for and importance of technological investigations have been felt by the industry as never before in its history. By way of illustration as to the necessity for such work, in 1915 the products of the fisheries of California exceeded 93,000,000 pounds and in 1919 the catch is reported to have approximated 260,000,000 pounds, about 90 per cent of which is made up of species of importance in the canning industry. Within a period of a decade more than 40 canneries have been built and equipped in that State, and the annual pack of canned fish has grown from a few thousand cases to more than 1,500,000 cases. Under such conditions of expansion and growth it is not surprising to

find the number of differing processes employed approximating the number of plants operated. Products, time, labor, and capital have been wasted through ignorance and for lack both of the development of standard methods that will yield high quality products and of specific information as to the best and most economical procedure.

The annual losses in other sections, as the New England district, resulting from rusting of mackerel and other fish and from reddening of cod and related species are heavy. It is important that technological studies be made of such problems to develop means of preventing or at least minimizing such losses. The bureau is endeavoring to utilize its facilities in this field to the fullest possible degree but is greatly hampered by its inability to obtain and retain the services of a properly trained personnel, because of the inadequacy of the salaries of such positions as have been created.

PRESERVATION OF FISH NETS.

A review of the literature on the subject of net preservation has been made and a report issued which includes a discussion of the fundamental principles in the light of chemistry so far as they are known. This report was prepared in nontechnical language in so far as practicable to make it readily understandable and includes such subjects as nature of disintegration of nets, coloring of nets, preservation of nets by tarring materials and by methods not dependent on tarring materials, and references to the literature.

Following this preliminary work an investigation of the subject has been begun. This includes tests of the relative value of various net preservatives, including some in commercial use, also tests to determine the increase in weight of the net by addition of the preservative, shrinkage, breaking strength, wearing quality, etc. Treated lines are being used by actual fishermen as one phase of wearing tests. In addition efforts are being made to effect improvements in the preservatives used and in the methods of their application.

BRINE FREEZING OF FISH.

Although the work in this field was seriously interfered with during a considerable part of the year progress has been made. A paper reviewing the present status of brine freezing was prepared by the chief technologist and issued for the information of the trade. This emphasizes the need of giving more attention to improving methods of freezing and storage and less to types of machinery; discusses the shorter time required to freeze fish in brine than in air, the non-evaporation of moisture from the fish during the brine freezing, the bright luster of the brine-frozen fish, and the pliability of fins and tail; and presents evidence that defrosted brine-frozen fish are firmer and may be held satisfactorily for a considerable time and that such fish may be frozen again. Mention of the difficulties of glazing brine-frozen fish is also made, and methods by which such fish may be properly glazed are given. It is stated that the most important aspect of brine freezing awaiting development is its practical application on a large scale. It is to this feature that the investigations now in progress are especially directed.

The conclusions reached by the author are that brine freezing promises to contribute much of value to improvements in the dis-

tribution of fish; that it gives an unquestionably superior product; that such difficulties as have been encountered are not insuperable; and that the proper design of suitable plants is the principal problem ahead.

THE FRY BATH IN CANNING SARDINES.

In the process of canning sardines in southern California, after the fish have been scaled and cleaned they are brined in a strong salt solution, dried, and then fried by being passed through a cottonseed-oil bath heated to a temperature of from 100 to 115° C., after which they are cooled and packed in tins with the proper sauces, then sealed and retorted. The fry bath consists of a long metal tank with a horizontal set of steam coils, midway of its depth, and an endless-chain conveyor passing over the coils carrying the trays of fish throughout the length of the tank. The tank is filled with water almost to the bottom of the coils, and sufficient oil is added to cover the baskets of fish passing through. With continued use the oil becomes viscous and almost black in color and acquires a disagreeable taste and odor. In addition some of the oil is carried by the fish to the tin and detracts from the quality of the pack. The packers have endeavored to diminish these difficulties by mechanical and chemical treatment, as the frequent renewal of the oil is expensive, but have met with little success. In view of the large quantity of oil used, the failure to develop satisfactory means of purification, and the effects on the character of the pack, the problem is one of some importance. A study of the changes taking place in the oil used has been made at the bureau's experimental laboratory at San Pedro, Calif., and the following conclusions have been reached:

1. The use of corn oil and a hydrogenated oil, in addition to cottonseed oil, for frying sardines is feasible.
2. The presence of varying quantities of fish oil and the action of air and heat are largely responsible for the changes which take place in fry-bath oil.
3. Sardine oil is present in varying quantities in the fry bath in which sardines have been fried. When fat sardines are used its increase is so rapid that in a short time the fish are being fried in oil which is largely fish oil. To keep the fish oil content of the fry bath as low as possible, the sardines should be fried in the minimum quantity of oil that can be used. This is applicable to all cases except when fat sardines are being used with resultant increase in oil content of bath. In such cases the oil should be allowed to increase as far as conditions will permit and as long as such a condition exists.

Attempts to reclaim used fry-bath oil by chemical treatment were unsuccessful. It is improbable that a cheap successful method will be developed. The presence of small amounts of the fry-bath oil can be detected in the canned sardines when they are eaten, and it is believed cause the lingering taste often observed some hours after one has eaten a considerable quantity of the fish.

In conclusion, the investigation points to the desirability of developing a satisfactory substitute for the fry bath. It is probable, however, that no method developed will wholly displace frying in oil, as the trade in some quarters appears to demand fish put up in

this manner. On the other hand, it is believed that a pack in which the use of the fry bath is eliminated may appeal to persons who do not now use sardines because the flavor of the fried product is distasteful.

SALTING RIVER HERRING.

Lack of satisfactory markets and high transportation rates are reported to have prevented large-scale salting of river herring on the St. Johns River, Fla. The 1921 pack of fish put up according to the bureau's recommendations and demonstrations amounted to about 125,000 fish, all of which were marketed. A packer reports that some of the fish retained in the original brine for a period of three months were in perfect condition. By adherence to the bureau's methods an excellent product is obtained, and with improvement in the market situation it is anticipated that packing operations will be conducted on a much larger scale during the coming season, as the packers are desirous of developing this additional outlet for their catch.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS OF THE UNITED STATES AND ALASKA, 1921.

The bureau has made a canvass of the canned fishery products and by-products of the United States and Alaska in 1921 for the use of the trade as an aid to the intelligent prosecution of business and to prevent waste or shortage through over or under production. These statistics also serve to reveal the growth, extent, and importance of the industry as a guide to its perpetuation and development. In the presentation of the statistics many of the combinations of States or products have been necessary to avoid disclosing private enterprise. It is believed that their value will be enhanced by showing the products in greater detail, and when the trade is prepared to acquiesce in presenting them in such detail the Bureau will gladly give them in more detailed form that they may be of the greatest possible use. The total value of canned products in 1921 was $46,634,706 and of by-products $8,351,827. The statistics are shown in Statistical Bulletin No. 526, and discussions and statistics follow.

CANNED FISHERY PRODUCTS.

CANNED SALMON.

In 1921 there were 138 plants engaged in canning salmon on the Pacific coast of the United States and Alaska. Of this number 81 were operated in Alaska, 23 on Puget Sound, 20 on the Columbia River, 10 on coastal streams of Washington, 2 on coastal streams of Oregon, and 2 in California.

The pack during 1921, on the basis of 48 pounds of fish to the case, amounted to 3,599,774 cases, valued at $28,867,169, of which 72.14 per cent of the quantity and 68.01 per cent of the value are credited to Alaska, 17.51 per cent of the quantity and 15.20 per cent of the value to Puget Sound, 9.28 per cent of the quantity and 15.22 per cent of the value to the Columbia River, and 1.07 per cent of the quantity and 1.57 per cent of the value to the coastal streams of Washington, Oregon, and California. Compared with the pack of 1915 there has been a decrease of 2,861,545 cases in quantity and an increase of $915,588 in value.

In Alaska the pack amounted to 2,596,826 cases, valued at $19,632,744, divided as follows: Red or sockeye, 1,765,798 cases, valued at $15,841,404; humpback or pink, 423,984 cases, valued at $1,788,778; chum or keta, 255,495 cases, valued at $942,525; coho or silver, 106,555 cases, valued at $600,140; and king or spring, 44,994 cases, valued at $459,897.

On Puget Sound the pack of sockeyes amounted to 97,035 cases, valued at $1,782,449; of pinks, 402,688 cases, valued at $1,732,219; of cohos, 76,806 cases, valued at $570,587; of chums, 28,431 cases, valued at $103,864; of red springs, 11,516 cases, valued at $136,605; of pink springs, 4,218 cases, valued at $22,791; of white springs, 9,628 cases, valued at $38,231; and of steelheads, 9 cases, valued at $136. The total pack on Puget Sound amounted to 630,331 cases, valued at $4,386,882.

The Columbia River pack, amounting to 334,009 cases, valued at $4,394,335, was graded as follows: Chinook, fancy, 231,632 cases, valued at $3,507,776; chinook, standard, 34,916 cases, valued at $354,295; chinook, pink, 9,067 cases, valued at $54,791; chinook, white, 7,372 cases, valued at $25,108; coho or silver, 30,395 cases, valued at $213,004; steelhead, 12,510 cases, valued at $133,747; sockeye or blueback, 6,851 cases, valued at $101,848; and chum or keta, 1,266 cases, valued at $3,766.

Canneries located on coastal streams of Washington packed 13,552 cases, valued at $93,082, consisting of 2,571 cases of chinooks or springs, valued at $28,538; 4,321 cases of cohos or silvers, valued at $22,537; 1,068 cases of sockeyes or bluebacks, valued at $21,350; 5,435 cases of chums, valued at $20,029; and 157 cases of humpbacks or pinks, valued at $628.

The pack on Oregon coastal streams, amounting to 15,760 cases, valued at $226,516, consisted of 15,638 cases of chinooks or springs, valued at $225,966, and 122 cases of cohos or silvers, valued at $550.

In California the pack was made up entirely of chinooks to the amount of 9,296 cases, valued at $133,610.

The following tables give the quantity and value of the pack of the various species of salmon canned during 1921, by geographic divisions, for the Pacific coast of the United States and Alaska, and by fishing districts for the Pacific coast States:

PACK OF CANNED SALMON ON THE PACIFIC COAST OF UNITED STATES AND ALASKA IN 1921, BY GEOGRAPHIC DIVISIONS.

Products.	Alaska.							
	Southeast.		Central.		Western.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
Coho or silver:								
½-pound flat	4,004	$31,846	80	$640			4,084	$32,486
1-pound flat	7,918	51,710					7,918	51,710
1-pound tall	78,880	431,666	9,630	50,299	6,043	$33,979	94,553	515,944
Total	90,802	515,222	9,710	50,939	6,043	33,979	106,555	600,140
Chum or keta:								
½-pound flat	608	3,183					608	3,183
1-pound tall	180,839	650,134	34,571	127,508	39,477	161,700	254,887	939,342
Total	181,447	653,317	34,571	127,508	39,477	161,700	255,495	942,525

PACK OF CANNED SALMON ON THE PACIFIC COAST OF UNITED STATES AND ALASKA IN 1921, BY GEOGRAPHIC DIVISIONS—Continued.

Products.	Alaska.							
	Southeast.		Central.		Western.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
Humpback or pink:								
½-pound flat	1,292	$8,774					1,292	$8,774
1-pound tall	415,489	1,750,743	7,147	$29,018	56	$243	422,692	1,780,004
Total	416,781	1,759,517	7,147	29,018	56	243	423,984	1,788,778
King, chinook, or spring:								
½-pound flat	2,396	37,840	1,665	24,588			4,061	62,428
1-pound flat	2,950	32,450	560	7,840	15,682	205,376	19,192	245,666
1-pound tall	3,763	25,396	6,404	47,843	11,574	78,564	21,741	151,803
Total	9,109	95,686	8,629	80,271	27,256	283,940	44,994	459,897
Red or sockeye:								
½-pound flat	17,958	279,429	29,970	440,769	12,903	90,179	60,831	810,377
1-pound flat	32,649	407,929	21,985	253,781	16,474	169,241	71,108	830,951
1-pound tall	54,325	453,350	531,087	4,599,963	1,048,447	9,146,763	1,633,859	14,200,076
Total	104,932	1,140,708	583,042	5,294,513	1,077,824	9,406,183	1,765,798	15,841,404
Grand total	803,071	4,164,450	643,099	5,582,249	1,150,656	9,886,045	2,596,826	19,632,744

Products.	Pacific Coast States.								Grand total.	
	Washington.		Oregon.		California.		Total.			
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
Coho or silver:										
½-pound flat	38,480	$334,568	15,473	$126,228			53,953	$460,796	58,037	$493,282
1-pound flat	26,745	179,104	3,639	22,740			30,384	201,844	38,302	253,554
1-pound tall	24,120	127,278	3,186	16,760			27,306	144,038	121,859	659,982
Total	89,345	640,950	22,298	165,728			111,643	806,678	218,198	1,406,818
Chum or keta:										
½-pound flat	629	3,497	42	168			671	3,665	1,279	6,848
1-pound flat	137	548	500	1,400			637	1,948	637	1,948
1-pound tall	33,624	121,326	200	720			33,824	122,046	288,711	1,061,388
Total	34,390	125,371	742	2,288			35,132	127,659	290,627	1,070,184
Humpback or pink:										
½-pound flat	37,621	225,017					37,621	225,017	38,913	233,791
1-pound flat	36,286	181,430					36,286	181,430	36,286	181,430
1-pound tall	328,939	1,326,400					328,939	1,326,400	751,631	3,106,404
Total	402,846	1,732,847					402,846	1,732,847	826,830	3,521,625
King, chinook, or spring:										
½-pound flat	53,920	904,234	111,149	1,677,694	6,712	$102,602	171,781	2,684,530	175,842	2,746,958
½-pound oval	328	7,216	29	638			357	7,854	357	7,854
1-pound flat	48,930	560,738	79,557	965,592	2,584	31,008	131,071	1,557,338	150,263	1,803,004
1-pound oval	2,770	46,514	2,653	43,735			5,423	90,249	5,423	90,249
1-pound tall	17,037	117,586	10,185	70,154			27,222	187,740	48,963	339,543
Total	122,985	1,636,288	203,573	2,757,813	9,296	133,610	335,854	4,527,711	380,848	4,987,608
Red or sockeye:										
½-pound flat	76,956	1,462,016	2,954	45,088			79,910	1,507,104	140,741	2,317,481
1-pound flat	22,810	363,102					22,810	363,102	93,918	1,194,053
1-pound oval	228	3,420					228	3,420	228	3,420
1-pound tall	1,989	31,824	17	197			2,006	32,021	1,635,865	14,232,097
Total	101,983	1,860,362	2,971	45,285			104,954	1,905,647	1,870,752	17,747,051
Steelhead:										
½-pound flat	2,060	24,444	4,302	54,754			6,362	79,198	6,362	79,198
1-pound flat	334	3,297	5,720	50,358			6,054	53,655	6,054	53,655
1-pound tall	103	1,030					103	1,030	103	1,030
Total	2,497	28,771	10,022	105,112			12,519	133,883	12,519	133,883
Grand total	754,046	6,024,589	239,606	3,076,226	9,296	133,610	1,002,948	9,234,425	3,599,774	28,867,169

PACK OF CANNED SALMON IN PACIFIC COAST STATES IN 1921, BY FISHING DISTRICTS.

Locality and species.	1-pound tall.		1-pound flat.		1-pound oval.	
	Cases.	Value.	Cases.	Value.	Cases.	Value.
Puget Sound:						
Coho or silver	18,633	$99,444	21,200	$148,296		
Chum or keta	27,687	99,916	137	548		
Humpback or pink	328,782	1,325,772	36,286	181,430		
Sockeye or blueback	1,989	31,824	22,810	363,102		
Chinook or spring—						
Red	451	3,603	7,805	82,647		
Pink	63	259	3,695	18,475		
White	9,085	35,527	243	972		
Total	386,690	1,596,345	92,176	795,470		
Columbia River:						
Coho or silver	4,845	25,115	8,824	51,676		
Chum or keta	702	2,101	500	1,400		
Sockeye or blueback	17	197			228	$3,420
Chinook or spring—						
Fancy	6,883	84,963	97,706	1,254,404	5,211	86,645
Standard	3,203	32,019	10,518	92,094		
Pink	1,610	5,151	1,170	6,559		
White	4,245	12,043	1,370	4,503		
Steelhead	103	1,030	6,054	53,655		
Total	21,608	162,619	126,142	1,464,291	5,439	90,065
Washington coast:						
Coho or silver	3,706	18,929	360	1,872		
Chum or keta	5,435	20,029				
Humpback or pink	157	628				
Chinook or spring	1,065	9,239	380	3,952		
Total	10,363	48,825	740	5,824		
Oregon coast:						
Coho or silver	122	550				
Chinook or spring	617	4,936	5,600	62,724	212	3,604
Total	739	5,486	5,600	62,724	212	3,604
California: Chinook			2,584	31,008		
Grand total	419,400	1,813,275	227,242	2,359,317	5,651	93,669

Locality and species.	½-pound flat.		½-pound oval.		Total.	
	Cases.	Value.	Cases.	Value.	Cases.	Value.
Puget Sound:						
Coho or silver	36,973	$322,847			76,806	$570,587
Chum or keta	607	3,400			28,431	103,864
Humpback or pink	37,620	225,017			402,688	1,732,219
Sockeye or blueback	72,236	1,387,523			97,035	1,782,449
Chinook or spring—						
Red	3,260	50,355			11,516	136,605
Pink	460	4,057			4,218	22,791
White	300	1,732			9,628	38,231
Steelhead	9	136			9	136
Total	151,465	1,995,067			630,331	4,386,882
Columbia River:						
Coho or silver	16,726	136,213			30,395	213,004
Chum or keta	64	265			1,266	3,766
Sockeye or blueback	6,606	98,231			6,851	101,848
Chinook or spring—						
Fancy	121,475	2,073,910	357	$7,854	231,632	3,507,776
Standard	21,195	230,182			34,916	354,295
Pink	6,287	43,081			9,067	54,791
White	1,757	8,562			7,372	25,108
Steelhead	6,353	79,062			12,510	133,747
Total	180,463	2,669,506	357	7,854	334,009	4,394,335
Washington coast:						
Coho or silver	255	1,736			4,321	22,537
Chum or keta					5,435	20,029
Humpback or pink					157	628
Sockeye or blueback	1,068	21,350			1,068	21,350
Chinook or spring	1,126	15,347			2,571	28,538
Total	2,449	38,433			13,552	93,082

PACK OF CANNED SALMON IN PACIFIC COAST STATES IN 1921, BY FISHING DISTRICTS—Continued.

Locality and species.	½-pound flat.		½-pound oval.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
Oregon coast:						
Coho or silver					122	$550
Chinook or spring	9,209	$154,702			15,638	225,966
Total	9,209	154,702			15,760	226,516
California: Chinook	6,712	102,602			9,296	133,610
Grand total	350,298	4,960,310	357	$7,854	1,002,948	9,234,425

CANNED SARDINES.

The pack of sardines in Maine in 1921 amounted to 1,350,631 cases, valued at $3,960,916, as compared with 2,450,268 cases, valued at $11,933,986, in 1919 and with 1,877,757 cases, valued at $7,435,056, in 1920. The pack of quarter-oils in 1919 was 1,902,430 cases, valued at $9,327,665, or an average of $4.90 per case; in 1920, 1,458,670 cases, valued at $5,669,352, or $3.88 per case, and in 1921, 1,127,578 cases, valued at $3,265,574, or $2.89 per case. The quantity of herring utilized was 73,706,536 pounds, valued at $441,353.

The pack of sardines in California in 1921 was 415,587 cases, valued at $2,346,446, of which 379,928 cases, with a value of $2,056,367, were 1-pound ovals, or an average price of $5.41 per case. It is reported that the pack in 1920 amounted to 1,062,996 cases and in 1919 to 1,150,616 cases. The quantity of pilchards utilized was 33,274,853 pounds, valued at $175,165. It will be noted that there has been a heavy curtailment in production in both fisheries as compared with previous years.

PACK OF SARDINES IN MAINE AND CALIFORNIA, 1921.

Sardines (herring).	Maine.		Sardines (pilchard).	California.	
	Cases.	*Value.*		*Cases.*	*Value.*
In oil: Quarters (100 cans)	1,127,578	$3,265,574	1-pound oval (48 cans)	379,928	$2,056,367
In mustard:			½-pound oval (48 cans)	11,357	44,881
Quarters (100 cans)	111,987	345,787	½-pound square (100 cans)	586	7,465
Three-quarters (48 cans)	110,520	346,825	¼-pound square (100 cans)	20,893	208,033
In tomato sauce: Halves and			¼-pound flat (100 cans)	2,485	26,050
1-pound (48 cans)	546	2,730	No. 10 round (6 cans)	338	3,650
Total	1,350,631	3,960,916	Total	415,587	2,346,446

CANNED SHAD AND ALEWIVES.

The canning of shad and shad roe is confined to the States of Oregon and Washington. In 1921 the pack of shad amounted to 841 cases, valued at $2,455, and of shad roe to 53 cases, valued at $142. These products are packed in half-pound flat and oval and 1-pound tall cans.

Most of the alewives are canned in the Chesapeake Bay district. The pack of fish amounted to 312 cases, valued at $813, and of roe to 40,530 cases, valued at $157,841. Reducing cases to number of cans, there were packed in 1921, 8,976 cans of fish and 1,197,288 cans

of roe in Maryland and Virginia, including a small pack in North Carolina, as compared with 27,144 cans of fish and 1,191,048 cans of roe in the Chesapeake Bay district in 1915.

PACK OF SHAD AND ALEWIVES, BY STATES, 1921.

SHAD.

Sizes.	Oregon.		Washington.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
½-pound flat (48 cans)	44	$132	315	$943	359	$1,075
½-pound oval (48 cans)	42	84			42	84
1-pound tall (48 cans)	328	984	112	312	440	1,296
Roe:						
½-pound flat (48 cans)			12	24	12	24
½-pound oval (48 cans)			17	51	17	51
1-pound tall (48 cans)			24	67	24	67
Total	414	1,200	480	1,397	894	2,597

ALEWIVES.

Sizes.	Maryland.		Virginia and North Carolina.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
No. 1 (48 cans)	50	$170	12	$43	62	$213
No. 2 (24 cans)	250	600			250	600
Roe:						
No. ½ (48 cans)			1,000	6,400	1,000	6,400
No. 1 (48 cans)	2,600	12,640	5,757	29,705	8,357	42,345
No. 2 (24 cans)	3,168	12,554	28,005	96,542	31,173	109,096
Total	6,068	25,964	34,774	132,690	40,842	158,654

CANNED ALBACORE, TUNA, AND MACKEREL IN CALIFORNIA.

The pack of albacore, tuna, and mackerel in California in 1921 amounted to 421,076 cases, valued at $3,085,956. In 1915, the only one of these products packed was albacore to the value of $1,517,858. From available data it appears that the 1921 pack of the tunas was smaller than for any year since 1915.

PACK OF ALBACORE, TUNA, AND MACKEREL IN CALIFORNIA, 1921.

Sizes.	Albacore.		Tuna.				Mackerel.	
			Bluefin and yellowfin.		Striped.			
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
¼-pound round	24,964	$134,876	4,695	$24,408	2,122	$8,577		
½-pound round	179,735	1,266,258	35,926	186,216	4,349	20,707	2,000	$11,000
½-pound oval	14,900	116,808	5,370	26,850	750	3,750		
1-pound round	72,016	754,089	3,434	32,123	10,906	76,895		
1-pound tall	831	9,557					255	1,275
1-pound oval	50,482	351,898	7,152	36,889				
4-pound tall	1,189	23,780						
Total	344,117	2,657,266	56,577	306,486	18,127	109,929	2,255	12,275

CANNED SHRIMP.

The pack of shrimp in the South Atlantic and Gulf States in 1921 amounted to 667,558 cases, valued at $3,804,781, as compared with a pack valued at $2,012,437 in 1918 and 448,443 cases, valued at $1,436,851, in 1916. Louisiana outranked the other States in 1921 with a pack of 273,218 cases, valued at $1,530,072, and Mississippi ranked second with a pack of 169,751 cases, valued at $958,268. The bulk of the shrimp are packed in No. 1 cans, 48 cans to the case.

PACK OF SHRIMP IN SOUTH ATLANTIC AND GULF STATES, 1921.

State.	No. 1 (4 dozen).		No. 1½ (2 dozen).		No. 2½ and No. 10 (2 dozen and ½ dozen).		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
Georgia [1]	69,193	$401,230	9,664	$55,998			78,857	$457,228
Florida	63,376	397,107	4,996	28,655			68,372	425,762
Alabama	68,086	380,210	9,116	51,819	158	$1,422	77,360	433,451
Mississippi	160,747	907,373	9,004	50,895			169,751	958,268
Louisiana	236,072	1,322,057	37,146	208,015			273,218	1,530,072
Total	597,474	3,407,977	69,926	395,382	158	1,422	667,558	3,804,781

[1] Includes the output of one plant in North Carolina.

CANNED CRABS.

In 1921 there were six establishments engaged in canning crabs, of which two each were in Virginia and Alaska and one each in Louisiana and Washington. The pack amounted to 11,960 cases, valued at $115,800. In 1920 the imports of crab meat amounted to 4,078,980 pounds, valued at $2,166,068. Of this amount, 4,013,530 pounds, valued at $2,144,928, are credited to Japan; 32,806 pounds, valued at $3,437, to Canada; 20,016 pounds, valued at $13,241, to Hongkong; and 12,628 pounds, valued at $4,462, to Norway.

PACK OF CRABS, BY STATES, 1921.

Sizes.	Virginia, Washington, Louisiana, and Alaska.	
	Cases.	*Value.*
3½ and 8 ounce (2 dozen)	840	$4,080
7½, 8, and 9 ounce (4 dozen)	7,550	69,780
15, 16, and 17 ounce (2 dozen)	3,570	41,940
Total	11,960	115,800

CANNED CLAMS.

The 1921 pack of canned clams amounted to 226,130 cases, valued at $1,166,507, of which 92,085 cases, valued at $509,122, were razor clams, packed chiefly in Oregon and Washington; 46,207 cases, valued at $212,846, hard clams, accredited to Florida and Washington; and 87,838 cases, valued at $444,539, soft clams, accredited to Maine and Massachusetts. The value of the pack of whole clams was $537,767; of minced clams, $446,298; and of clam bouillon, chowder, extract, and juice, $182,442.

Following are the statistics of canned clams, the combinations made in the tables being necessary to avoid disclosing private enterprise:

PACK OF CLAMS, BY STATES, 1921.

RAZOR CLAMS.

Sizes.	Oregon.		Washington and Alaska.		Total.	
	Cases.	Value.	Cases.	Value.	Cases.	Value.
Whole:						
7-ounce cans (4 dozen)	433	$3,464	5,499	$41,503	5,932	$44,967
9-ounce cans (4 dozen)	500	2,750			500	2,750
16-ounce cans (4 dozen)			[1] 1,420	9,940	1,420	9,940
45-ounce cans (½ dozen)			1,593	17,284	1,593	17,284
Minced:						
3½-ounce cans (4 dozen)	4,712	23,090	45,097	224,965	49,809	248,055
5-ounce cans (4 dozen)	3,421	19,166	24,728	144,335	28,149	163,501
9-ounce cans (4 dozen)	171	1,710	3,758	18,384	3,929	20,094
Juice:						
No. 1 cans (4 dozen)			20	55	20	55
No. 2 cans (2 dozen)			565	1,300	565	1,300
No. 10 cans (½ dozen)			168	1,176	168	1,176
Total	9,237	50,180	82,848	458,942	92,085	509,122

HARD CLAMS.

Sizes.	Florida and Washington.		Sizes.	Florida and Washington.	
	Cases.	Value.		Cases.	Value.
Whole:			Bouillon, chowder, and juice:		
No. 1 cans (4 dozen)	9,883	$58,175	No. 1 cans (4 dozen)	8,341	$30,211
No. 2 cans (2 dozen)	8,658	39,463	No. 2 cans (2 dozen)	2,430	7,190
No. 10 cans (½ dozen)	3,672	26,413	No. 3 cans (2 dozen)	4,788	20,413
Minced:			No. 10 cans (½ dozen)	184	501
No. 1 cans (4 dozen)	2,457	10,255	1½ and 3 ounce bottles	1,753	5,257
No. 2 cans (2 dozen)	901	3,708	7 and 14 ounce bottles (2 dozen)	3,060	10,575
No. 10 cans (½ dozen)	80	685			
			Total	46,207	212,846

SOFT CLAMS.

Sizes.	Maine and Massachusetts.		Sizes.	Maine and Massachusetts.	
	Cases.	Value.		Cases.	Value.
Whole:			Bouillon, chowder, and extract:		
4 and 5 ounce cans (4 dozen)	26,403	$134,203	2, 4, and 8 ounce jars and bottles (2 dozen)	1,349	$5,702
6 and 8½ ounce cans (2 dozen)	3,525	14,017	10 and 10½ ounce cans (2 dozen)	10,548	45,803
8-ounce cans (4 dozen)	10,075	67,783	1-pound cans (4 dozen)	3,735	17,555
10-ounce cans (2 dozen)	4,429	22,250	3 and 6 pound cans (2 dozen)	7,977	36,704
15 and 16 ounce cans (4 dozen)	13,416	68,571			
2-pound cans (2 dozen)[2]	6,381	31,951	Total	87,838	444,539

[1] Packed in Alaska. [2] Includes small pack of clam chowder.

CANNED OYSTERS.

The pack of oysters in 1921 amounted to 455,550 cases, valued at $2,179,271. Maryland leads in the quantity and value of the pack, Mississippi ranking second, and South Carolina third.

PACK OF OYSTERS, BY STATES, 1921.

Sizes.	Maryland.		North Carolina.		South Carolina.		Georgia.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
3-ounce cans (4 dozen)					200	$720		
4-ounce cans (4 dozen)	21,616	$77,698	450	$2,520	2,082	8,865		
5-ounce cans (4 dozen)	92,000	440,001	11,333	56,726	94,698	417,653	11,332	$60,760
6-ounce cans (4 dozen)	10,799	50,202			300	2,100	200	1,400
7-ounce cans (2 dozen)	262	900						
8-ounce cans (2 dozen)	5,679	28,930			450	1,980		
10-ounce cans (2 dozen)	25,975	179,944	2,734	14,056	17,687	69,993	1,092	5,460
12-ounce cans (2 dozen)	100	760					50	400
Total	156,431	778,435	14,517	73,302	115,417	501,311	12,674	68,020

Sizes.	Florida.		Alabama and Louisiana.		Mississippi.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
3-ounce cans (4 dozen)							200	$720
4-ounce cans (4 dozen)			1,310	$6,288	28,489	$132,951	53,947	228,322
5-ounce cans (4 dozen)	3,213	$14,758	6,125	28,210	75,878	376,247	294,579	1,394,355
6-ounce cans (4 dozen)			503	2,616			11,802	56,318
7-ounce cans (2 dozen)							262	900
8-ounce cans (2 dozen)			501	2,405	17,903	84,379	24,533	117,694
10-ounce cans (2 dozen)	418	2,006	503	2,515	21,668	105,828	70,077	379,802
12-ounce cans (2 dozen)							150	1,160
	3,631	16,764	8,942	42,034	143,938	699,405	455,550	2,179,271

MISCELLANEOUS CANNED FISHERY PRODUCTS.

In addition to the products given in the tables, there were packed in Maine, Massachusetts, and North Carolina 259,644 cases of miscellaneous fishery products, valued at $778,978; in California, 2,186 cases of abalone, valued at $15,496, 11,712 cases of barracuda, yellowtail, and fish cakes, valued at $77,967, and 666 cases of squid and mussels, valued at $4,998; and in Washington and Oregon, other canned salmon products to the value of $69,170.

BY-PRODUCTS OF THE FISHERIES.

The bureau has continued its efforts to bring about a more complete utilization of the waste products of the fisheries and their conversion into products of the greatest economic value. The postwar slump in the prices of scrap and oil served to curtail greatly the production as compared with recent years.

FISH OILS.

The production of fish oils in 1921 in the United States and Alaska amounted to 7,446,281 gallons, valued at $2,078,670. Of this amount the largest item was menhaden oil, 6,260,478 gallons, the production of other oils being as follows: Whale oil, 354,372 gallons; herring

oil, 283,815 gallons; sperm oil, 168,729 gallons; salmon oil, 71,522 gallons; cod and cod-liver oil, 49,772 gallons; and miscellaneous, 257,593 gallons. Imports of fish oils entered for consumption for the calendar year 1920 amounted to 2,268,736 gallons, valued at $2,462,232. This amount includes cod oil, 1,044,624 gallons, valued at $979,891; cod-liver oil, 445,167 gallons, valued at $892,965; herring and other fish oils, 575,842 gallons, valued at $402,325; seal oil, 13,085 gallons, valued at $11,761; sperm oil, 99,783 gallons, valued at $98,033; other whale oil, 86,788 gallons, valued at $75,176; and other rendered oils and combinations of, 3,447 gallons, valued at $2,081. The exports of fish oils in 1920 amounted to 428,292 gallons, valued at $406,966. Of this amount 253,494 gallons, valued at $185,502 went to England; 53,690 gallons, valued at $50,943, to Canada; 26,452 gallons, valued at $24,850, to Cuba; 14,662 gallons, valued at $30,431, to Mexico; 14,596 gallons, valued at $7,298, to Belgium; 13,513 gallons, valued at $36,564, to Germany; and 13,419 gallons, valued at $8,700, to France.

FISH SCRAP AND MEAL.

The production of fish and whale scrap and meal and shrimp bran in 1921 amounted to 107,273 tons, valued at $3,557,142. Of this amount 60,031 tons, valued at $2,613,361, was dried scrap and meal; 44,454 tons, valued at $895,140, acidulated scrap; 2,160 tons, valued at $31,827, crude or green scrap; and 628 tons, valued at $16,814, shrimp bran. Of the total quantity produced 89,559 tons are credited to the Atlantic and Gulf coast States and 17,714 tons to the Pacific coast States and Alaska. It is estimated that not less than 15,000 tons of the dried product produced on the Atlantic seaboard were used as fish meal for feeding purposes. This increased use of fish meal is directly attributable to the aid given by the Bureau of Fisheries and the Bureau of Animal Industry.

POULTRY GRIT AND LIME.

The demand for and use of ground oyster shells for poultry grit and lime for fertilizer has developed rapidly in recent years into an important industry. In fact, when consideration is given to the decline in the catch of oysters in recent years and the utilization of stocks accumulated before the demand became so great, it is to be expected that there will be a lessening of production and a decrease in the number of operators. At the same time efforts will be made to draw upon other similar materials, such as scallops, clams, etc., in an effort to meet the demand.

ANALYSES OF SHELLS OF OYSTERS AND SCALLOPS.

	Oysters.	Scallops.		Oysters.	Scallops.
Calcium carbonate	93.12	97.35	Magnesium oxide	0.25	0.32
Silica, iron, and aluminum oxides	3.55	.40	Calcium oxide	52.15	54.52

From the analyses it will be noted that the scallop shells have a much smaller percentage of impurities, silica, iron, and aluminum, than oyster shells. As the scallop shells grind to a snow-white

powder, it is possible that they may be superior to oyster shells for some purposes. As a poultry feed, it is possible that little difference will be found between the two. However, the bureau has arranged with the division of poultry husbandry of the Department of Agriculture to ascertain whether any differences can be detected.

In 1921 there were 54 plants engaged in the production of poultry grit or lime, of which 18 were in Maryland, 11 in Virginia, 5 in Louisiana, 4 in Mississippi, and 3 in Florida. The production of poultry grit amounted to 185,474 tons, valued at $1,759,120, and of lime to 73,764 tons, valued at $502,634, or a combined production of 259,238 tons, valued at $2,261,754.

PRODUCTION OF POULTRY GRIT AND LIME FROM GROUND OYSTER SHELLS, BY STATES, 1921.

State.	Poultry grit.		Lime.		Total.	
	Tons.	*Value.*	*Tons.*	*Value.*	*Tons.*	*Value.*
Rhode Island, Pennsylvania, and New Jersey	15,239	$157,372	5,241	$29,084	20,480	$186,456
Maryland	51,408	492,958	26,859	148,624	78,267	641,582
Virginia	26,150	325,125	33,478	306,645	59,628	631,770
North Carolina, South Carolina, and Georgia	2,957	26,630	1,555	9,535	4,512	36,165
Florida and Alabama	48,855	392,340	3,045	4,810	51,900	397,150
Mississippi, Louisiana, and Texas	40,865	364,695	3,586	3,936	44,451	368,631
Total	185,474	1,759,120	73,764	502,634	259,238	2,261,754

MENHADEN INDUSTRY.

In 1921 there were 39 factories engaged in utilizing menhaden for the production of scrap, meal, and oil, distributed as follows: Massachusetts, 2; Connecticut, 1; New York, 2; New Jersey, 3; Delaware, 1; Virginia, 14; North Carolina, 15; and Florida, 1. The number of menhaden utilized was 1,031,540,831, or 618,924,499 pounds, valued at $1,929,219, as compared with 1,061,843,750 menhaden, or 637,-106,250 pounds, valued at $2,210,165, in 1912. The yield of scrap and meal in 1921 was 82,662 tons, valued at $2,286,095, as compared with 88,520 tons, valued at $2,138,165, in 1912, and 6,260,478 gallons of oil, valued at $1,719,892, in 1921, as compared with 6,651,203 gallons, valued at $1,551,990, in 1912.

PRODUCTS OF MENHADEN INDUSTRY, BY STATES, 1921.

Products.	Massachusetts, Connecticut, and New York.		New Jersey and Delaware.		Virginia.	
	Quantity.	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*
Fish utilized: Menhaden ....number..	228,229,333	$506,906	84,760,000	$179,710	403,340,000	$806,120
Manufactured products:						
Dry scrap and fish meal ....tons..	125	5,875			30,311	1,106,855
Acidulated scrap....do....	24,850	520,000	10,760	215,200		
Crude or green scrap ....tons..	350	10,500				
Total ....do....	25,325	536,375	10,760	215,200	30,311	1,106,855
Oil....gallons..	2,066,812	591,745	789,666	187,377	2,210,000	605,760
Grand total		1,128,120		402,577		1,712,615

PRODUCTS OF MENHADEN INDUSTRY, BY STATES, 1921—Continued.

Products.	North Carolina and Florida.		Total.	
	Quantity.	Value.	Quantity.	Value.
Fish utilized: Menhaden........number..	315,211,498	$436,483	[1]1,031,540,831	$1,929,219
Manufactured products:				
Dry scrap and fish meal........tons..	7,422	267,725	[2]37,858	1,380,455
Acidulated scrap........do....	8,844	159,940	44,454	895,140
Crude or green scrap........do....	....	....	350	10,[illegible]
Total........	16,266	427,665	82,662	2,286,095
Oil........gallons..	1,194,000	335,010	6,260,478	1,719,892
Grand total........	....	762,675	....	4,005,987

[1] 618,924,499 pounds.
[2] Of this quantity 5,396 tons, valued at $250,130, were reported as sold as fish meal.

MISCELLANEOUS BY-PRODUCTS.

In addition to the production of poultry grit and lime and the products of the menhaden industry, miscellaneous by-products—scrap, meal, and oil, shrimp bran, liquid glue, shark and porpoise hides, agar-agar, fish-scale essence, shark fins, whalebones (skeletons), etc.—were produced to the value of $2,084,086. It is impracticable to reveal the quantity and value of many of these products without disclosing private enterprise.

MISCELLANEOUS FISHERY BY-PRODUCTS, BY STATES, 1921.

Products.	Maine and Massachusetts.		New York, Maryland, and Virginia.		North Carolina, Florida, Mississippi, and Louisiana.		California.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fish scrap and meal:								
Dried......tons..	2,365	$74,817	1,344	$38,035	750	$36,750	15,293	$926,020
Crude or green ....tons..	1,810	21,327	....	....	....	....	....	....
Shrimp bran ....tons..	....	....	....	....	628	16,814	....	....
Oil:								
Sardine .gallons..	....	....	....	....	....	....	170,977	35,760
Herring....do....	27,900	5,499	....	....	....	....	....	....
Sperm oil..do....	168,729	94,767	....	....	....	....	....	....
Liver......do....	43,757	16,193	....	....	....	....	....	....
Cod-liver..do....	6,015	3,965	....	....	....	....	....	....
Miscellaneous ......gallons..	1,161	1,033	33,585	4,520	16,499	4,970	451,770	123,115
Liquid glue....do....	347,048	364,415	....	....	....	....	....	....
Miscellaneous by-products..pounds..	1,125	12,000	....	....	191,840	24,184	340,042	10,462
Total........	....	594,016	....	42,555	....	82,718	....	1,095,357

Products.	Oregon and Washington.		Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fish scrap and meal:						
Dried........tons..	1,743	$116,604	678	$40,680	22,173	$1,232,906
Crude or green........do....	....	....	....	....	1,810	21,327
Shrimp bran........do....	....	....	....	....	628	16,814
Oil:						
Salmon........gallons..	56,512	16,060	15,010	4,102	71,522	20,162
Sardine........do....	....	....	....	....	170,977	35,760
Herring........do....	....	....	84,938	21,236	112,838	26,735
Sperm oil........do....	....	....	....	....	168,729	94,767
Liver........do....	....	....	....	....	43,757	16,193
Cod-liver........do....	....	....	....	....	6,015	3,965
Miscellaneous........do....	108,950	27,558	....	....	611,965	161,196
Liquid glue........do....	....	....	....	....	347,048	364,415
Miscellaneous by-products........pounds..	288,000	43,200	....	....	821,007	89,846
Total........	....	203,422	....	66,018	....	2,084,086

FIG. 2.—MENHADEN STEAMERS ON FISHING AREAS.

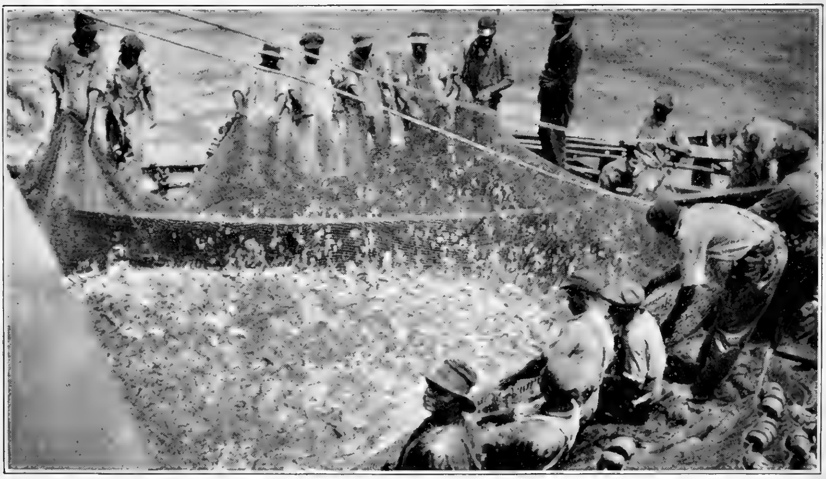

FIG. 3.—MENHADEN FISHERY. PURSE-SEINE CATCH BUNTED UP FOR TRANSFER TO VESSEL'S HOLD.

FISH LEATHER.

There is continued interest in the use of shark skins for tanning into leather, and fancy leathers of excellent quality and appearance are being tanned. It has also been demonstrated that shoes made of shark leather wear fully as well as high-grade calfskin shoes and retain a better finish without abrasions. The present tendency in finishing these leathers is to retain the special characteristics and finish, which adds much to the attractiveness of such articles. As the unexpended balance of the special appropriation for "Developing aquatic sources of leather" was not made available for use during the current fiscal year, the bureau is restricted by lack of funds as to the service it might render in developing this industry. Of the $10,000 provided in the act approved by Congress June 12, 1917, there were expended during the five years ended June 30, 1922, $5,759.39.

FISH-SCALE ESSENCE.

It is reported that the production of fish-scale essence in the United States is sufficient to satisfy the demand, and inquiries have been received from abroad relative to obtaining supplies in this country. It is estimated that this commodity was produced in 1921 to a value exceeding $15,000.

AGAR-AGAR.

Agar-agar, one of the most useful seaweed products, is now being produced in southern California and gives promise of becoming an industry of some importance. It is reported that along the coast of southern California there are at least 15 species of algæ suitable for the purpose as compared with 7 or 8 in Japan. The red algæ, from which agar is chiefly made, grows unusually large on the California coast, reaching a height of 3 or 4 feet. The material is gathered chiefly by Japanese divers and to some extent by wading along the beaches at low tide. It is dried in the sun on the beach and is baled for shipment to the factory.

The manufacturers are endeavoring to develop gelatinous substances of varying characters suited to a large number of new uses for such products. The extent of the supply of the seaweeds suitable for the purpose will, it is believed, fix the limitations on the industry.

NEW ENGLAND VESSEL FISHERIES.

GENERAL STATISTICS.

In the vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., during the past year there was a decrease in the number of trips and also in the quantity and value of the products as compared with the previous year. At Boston there was a decrease in the products landed of 11.96 per cent in quantity and 31.71 per cent in value, and at Gloucester a decrease of 29.36 per cent in the quantity and 36.98 per cent in the value. In the products landed at Portland there was an increase of 3.84 per cent in the quantity but a decrease of 2.83 per cent in the value. Statistics of these fisheries have been collected by the local agents and published in monthly bulletins showing by species and fishing grounds the quantities and values of fishery products landed by American and Canadian fishing vessels during the year

at these ports. Two annual bulletins have been issued, one showing the catch by months and the other by fishing grounds.

The fishing fleet at these ports during the calendar year 1921 numbered 398 sail, steam, and gasoline screw vessels, including 23 American and 3 Canadian steam trawlers. These vessels landed at Boston 3,078 trips, aggregating 104,368,629 pounds of fish, valued at $4,190,135; at Gloucester, 2,073 trips, aggregating 33,016,166 pounds, valued at $920,250; and at Portland, 2,055 trips, aggregating 13,480,311 pounds, valued at $612,244. The total for the three ports amounted to 7,206 trips, aggregating 150,865,106 pounds of fresh and salted fish, having a value to the fishermen of $5,722,629. This total includes 72 trips—49 at Boston, 7 at Gloucester, and 16 at Portland—landed by 22 Canadian fishing vessels, amounting to 4,222,319 pounds of fish, valued at $127,549. Of this quantity, 1,849,702 pounds, valued at $65,388, were landed at Boston; 239,209 pounds, valued at $8,409, at Gloucester; and 2,133,408 pounds, valued at $53,752, at Portland. There was an increase of 4 vessels and 18 trips and of 1,634,101 pounds in the quantity and $8,521 in the value of fish landed as compared with the previous year. These fish were landed in accordance with an arrangement with the Canadian Government as an emergency war measure granting reciprocal privileges to fishing vessels, by which Canadian fishing vessels were permitted to land their fares at American ports direct from the fishing grounds. Canadian vessels began to utilize this privilege in April, 1918, and the arrangement was canceled to take effect July 15, 1921, but a number of trips were admitted after that date, the last one being landed in September.

Compared with the previous year there was a decrease of 400 trips, or 5.25 per cent, in the total number landed by the fishing fleet at Boston, Gloucester, and Portland and of 27,415,595 pounds, or 15.37 per cent, in the quantity and of $2,504,384, or 30.44 per cent, in the value of the products landed. The only important species showing an increase in both quantity and value was halibut. The catch of halibut increased 1,876,698 pounds, or 49.52 per cent, in quantity and $61,253, or 8.25 per cent, in value. The catch of cusk increased 243,676 pounds, or 13.13 per cent, in quantity but decreased $10,241, or 21.30 per cent, in value. There was a decrease in both quantity and value of the catch of all the other more important species. The catch of cod decreased 8,750,568 pounds, or 14.05 per cent, in quantity and $906,870, or 34.38 per cent, in value; haddock, 7,866,768 pounds, or 10.45 per cent, in quantity and $693,882, or 25.32 per cent, in value; hake, 185,248 pounds, or 3.92 per cent, in quantity and $44,273, or 28.77 per cent, in value; pollock, 1,615,890 pounds, or 18.87 per cent, in quantity and $97,486, or 37.19 per cent, in value; mackerel, 3,909,541 pounds, or 53.60 per cent, in quantity and $427,468, or 56.01 per cent, in value; herring, 4,384,444 pounds, or 62.65 per cent, in quantity and $125,894, or 75.70 per cent, in value; and swordfish, 934,024 pounds, or 36.89 per cent, in quantity and $175,796, or 35.57 per cent, in value. The catch of Newfoundland herring declined from 3,097,024 pounds, valued at $110,157, in 1920, to 551,400 pounds, valued at $19,584, in 1921. In the various other species combined there was a decrease of 1,889,486 pounds, or 37.89 per cent, in quantity and of $83,727, or 38.08 per cent, in value.

The catch of cod, haddock, and hake is sold in different grades as landed from the vessels. Cod are sold as large, market, and scrod; haddock as large and scrod; and hake as large and small. It will be noticed in the statistics that the quantity of scrod cod and scrod haddock is very small as compared with that of the other grades of these species. This is said to be due to the fact that the price received for scrod cod and scrod haddock is so low that the fishermen do not save all that are caught. The catch of scrod cod landed at these ports during the year was 1,150,577 pounds, valued at $10,844, and of scrod haddock only 30,562 pounds, valued at $535.

The following tables present in detail, by fishing grounds and by months, the fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American and Canadian fishing vessels for the calendar year 1921. The weights of fresh and salted fish given in these statistics represent the fish as landed from the vessels, and the values are those received by the fishermen. The grades or sizes given for certain species are those recognized in the trade.

STATEMENT, BY FISHING GROUNDS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1921.

Fishing grounds.	Number of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 2½ pounds).				Scrod (1 to 2½ pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	59	666,927	$28,149			396,558	$10,053			6,425	$55		
Western Bank	26	208,900	9,819	9,760	$390	57,450	1,471	6,595	$198				
Quereau Bank	16	36,785	1,386			6,500	172						
Grand Bank	34	22,635	876	3,850	173			400	12				
Cape Shore	59	207,578	11,376			234,350	6,436			20,100	190		
Gulf of St. Lawrence	1	24,750	1,052										
Roseway Bank	1	14,000	1,440			18,300	828			7,000	70		
By Canadian vessels:													
La Have Bank	2	24,575	789			11,970	398			1,345	7		
Western Bank	2	2,000	150			5,550	167						
West of 66° W. longitude.													
By American vessels:													
Browns Bank	256	3,306,450	159,261	9,500	333	3,021,262	80,872			94,220	815		
Georges Bank	706	10,305,759	370,550			4,508,860	111,477			150,255	1,336		
Clark Bank	2	24,140	1,024			22,050	372			850	4		
Fippenies Bank	9	34,535	2,964			26,290	1,205			5,470	88		
Middle Bank	93	118,941	8,015			111,024	3,810			28,170	297		
Jeffreys Ledge	123	129,615	8,674			129,375	4,429			57,170	542		
South Channel	740	2,517,620	130,441			2,268,464	60,155			160,420	1,433		
Nantucket Shoals	32	85,540	4,772			158,735	4,444			6,605	81		
Off Chatham	92	361,245	15,520			233,300	5,942			24,475	232		
Seal Island	1	23,800	833			20,000	400						
Shore, general	770	916,775	42,388			389,866	11,861			33,425	300		
By Canadian vessels:													
Browns Bank	20	202,531	8,819			402,390	7,982			11,715	106		
Georges Bank	22	200,600	7,415			224,610	3,694			5,470	65		
South Channel	3	4,095	191			9,100	204						
Total	**3,078**	19,439,796	815,904	23,110	896	12,256,004	316,372	6,995	210	613,115	5,621		

LANDED AT GLOUCESTER.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	26	612,189	13,288	7,425	295	744,634	10,589	3,635	122	5,545	42		
Western Bank	38	735,552	14,733	670,465	28,075	440,280	6,718	449,455	17,189	3,650	52	25,935	$585
Quereau Bank	16	96,441	2,050	172,986	7,267	44,480	756	39,020	1,393	405	3	1,055	24
Green Bank	18	53,853	1,273	143,086	5,769	2,535	34	12,872	442			2,445	44
Grand Bank	60	145,743	3,158	1,440,497	60,576	6,050	98	655,115	24,336	110	1	57,760	1,364
St. Peters Bank	6	2,400	36	253,925	10,567	195	2	246,840	9,197			12,310	259
Sambro Bank	1			8,620	345			1,800	63			100	2
Burgeo Bank	1			5,285	211			320	11				
Cape Shore	30	97,975	2,414			113,585	2,212	6,600	173	4,030	34	250	3
The Gully	15	12,515	289	158,420	6,266	3,270	54	27,175	1,026				
By Canadian vessels:													
Western Bank	2	400	10			4,315	80			400	4		
Quereau Bank	1			19,150	795			2,340	82				
Cape Shore	1					15,315	306			2,000	20		
West of 66° W. longitude.													
Browns Bank	53	1,012,368	22,015	20,020	831	1,219,446	20,305	11,235	364	17,395	132	185	5
Georges Bank	195	3,663,565	81,707	435,393	18,108	1,481,331	24,302	81,682	2,928	39,245	337	4,255	93
Middle Bank	1			62,065	2,638			15,400	578			235	2
South Channel	41	54,645	1,163			148,785	2,442			795	7		
Shore, general	1,558	1,289,733	45,958	525	21	6,615	104			1,485	19		
By Canadian vessels: Georges Bank	3			41,130	1,724			40,960	1,502			2,735	54
Total	2,073	7,777,379	188,094	3,438,992	143,488	4,230,836	68,002	1,594,449	59,406	75,060	651	107,265	2,435
LANDED AT PORTLAND.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	4	13,370	334	2,250	45	18,130	317	1,225	18	3,770	19		
Western Bank	9			61,940	2,987			2,600	20				
Quereau Bank	9			22,390	1,008			800	30				
Grand Bank	17	5,890	265	37,438	1,685	155	6	5,165	193				
Cape Shore	7			110	5			76	3				
The Gully	10	22,945	507	53,670	2,655	3,150	54	10,045	377				
By Canadian vessels:													
La Have Bank	1			14,340	717								
Western Bank	10	241,500	4,362	6,625	281	214,060	4,289	2,395	84	1,000	20		
Grand Bank	1	20,800	726										

STATEMENT, BY FISHING GROUNDS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1921—Continued.

Fishing grounds.	Number of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 2½ pounds).				Scrod (1 to 2½ pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT PORTLAND—continued.													
West of 66° W. longitude.													
By Canadian vessels—Continued.													
Georges Bank	25			8,550	$385			630	$24				
Cashes Bank	3	9,025	$199			3,495	$58			495	$3		
Fippenies Bank	4	15,170	568			6,970	225			1,580	12		
Platts Bank	75	194,464	8,706			104,614	2,749			42,620	227		
Jeffreys Ledge	175	223,179	11,374			233,311	5,821			102,764	577		
Shore, general	1,690	1,598,191	65,055	6,618	329	430,510	11,054	415	16	202,233	1,266	675	$13
By Canadian vessels: South Channel	1	665	20										
Total	2,055	2,345,199	92,116	213,931	10,097	1,014,395	24,573	23,351	765	354,462	2,124	675	13
Grand total	7,206	29,562,374	1,096,114	3,676,033	151,481	17,501,235	408,947	1,624,795	60,381	1,042,637	8,396	107,940	2,448

Fishing grounds.	Number of trips.	Haddock.						Hake.					
		Large (over 2½ pounds).				Scrod (1 to 2½ pounds).		Large (6 pounds and over).				Small (under 6 pounds).	
		Fresh.		Salted.		Fresh.		Fresh.		Salted.		Fresh.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	59	939,715	$37,201					2,010	$138			19,715	$307
Western Bank	26	225,400	8,325									4,000	118
Quereau Bank	16											3,500	40
Grand Bank	34											5,020	90
Cape Shore	59	105,780	2,429									5,900	141
Gulf of St. Lawrence	1	12,000	255										
Roseway Bank	1	2,900	161										
By Canadian vessels:													
La Have Bank	2	49,300	2,447										
Western Bank	2	13,000	540										
West of 66° W. longitude.													
By American vessels:													
Browns Bank	256	3,650,682	155,035					10,375	266			57,710	1,389
Georges Bank	706	14,501,838	419,284			18,700	$374	7,915	342			50,730	1,323
Clark Bank	2	68,700	2,245									1,300	39
Fippenies Bank	9	24,565	1,523					7,010	494			75,568	2,558
Middle Bank	93	736,328	34,524					30,760	2,336			171,634	6,648
Jeffreys Ledge	123	487,100	21,029					20,005	1,389			242,585	6,139
South Channel	740	32,101,721	957,824			2,200	31	367,219	9,670			1,603,571	30,298
Nantucket Shoals	32	123,765	2,564									1,540	114
Off Chatham	92	1,372,625	56,631					24,950	1,012			75,177	2,590
Seal Island	1	325	3										
Shore, general	770	293,407	12,364			250	3	14,920	407			155,988	2,796
By Canadian vessels:													
Browns Bank	20	45,485	1,546										
Georges Bank	22	198,940	6,581										
South Channel	3	267,000	8,437									800	8
Total	3,078	55,220,576	1,730,948			21,150	408	485,164	16,054			2,474,738	54,598

STATEMENT, BY FISHING GROUNDS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1921—Continued.

Fishing grounds.	Number of trips.	Haddock.						Hake.					
		Large (over 2½ pounds).				Scrod (1 to 2½ pounds).		Large (6 pounds and over).				Small (under 6 pounds).	
		Fresh.		Salted.		Fresh.		Fresh.		Salted.		Fresh.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT GLOUCESTER.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	26	421,575	$3,940					34,225	$339				
Western Bank	38	128,080	1,152					6,513	69	6,220	$112		
Quereau Bank	16	83,360	780	2,950	$44			5,960	62	2,130	32		
Green Bank	18							8,010	101	4,163	66		
Grand Bank	60			65	1			27,205	277	26,555	500		
St. Peters Bank	6							270	2	1,080	14		
Burgeo Bank	1									150	3		
Cape Shore	30	23,945	240					3,310	33				
The Gully	15	155	1					2,525	32	720	14		
By Canadian vessels:													
Western Bank	2	47,290	1,182										
Quereau Bank	1									60	1		
Cape Shore	1							290	6				
West of 66° W. longitude.													
Browns Bank	53	647,465	5,636	10,925	110			19,550	196				
Georges Bank	195	2,832,379	31,807					51,680	556	895	17		
South Channel	41	2,362,365	21,723					28,305	244				
Shore, general	1,558	2,665,205	135,429					404,021	15,890				
By Canadian vessels: Georges Bank	3	420	8	1,350	27								
Total	2,073	9,212,239	201,898	15,290	182			591 864	17,807	41,973	759		

LANDED AT PORTLAND.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	4	17,440	615									450	5
Grand Bank	17									200	3		
Cape Shore	7									60	3		
The Gully	10											80	2
By Canadian vessels:													
La Have Bank	1											2,300	17
Western Bank	10	1,306,965	27,779			300	6						
Grand Bank	1											1,575	51
West of 66° W. longitude.													
Cashes Bank	3	30	1									660	4
Fippenies Bank	4	9,870	622			105	1					2,615	49
Platts Bank	75	68,101	4,122			590	10	31,215	660			163,350	3,055
Jeffreys Ledge	175	606,886	34,071			5,561	68	12,635	366			305,998	7,153
Shore, general	1,690	728,615	41,965			2,856	42	15,884	593			405,347	8,424
By Canadian vessels: South Channel	1	196,135	3,432										
Total	2,055	2,934,042	112,607			9,412	127	59,734	1,619	260	6	882,375	18,760
Grand total	7,206	67,366,857	2,045,453	15,290	182	30,562	535	1,136,762	35,480	42,233	765	3,357,113	73,358

STATEMENT, BY FISHING GROUNDS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1921—Continued.

Fishing grounds.	Number of trips.	Pollock.				Cusk.				Halibut.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	59	61,565	$1,235			75,905	$1,227			127,547	$20,210		
Western Bank	26	2,810	79			4,190	66	800	$16	457,669	71,043		
Quereau Bank	16					3,275	21			377,521	62,124		
Green Bank	4									170,016	22,479		
Grand Bank	34									1,215,069	135,558		
St. Peters Bank	3									86,633	15,281		
Burgeo Bank	1									34,853	5,051		
Cape Shore	59	57,220	1,064			11,145	221			4,400	739		
Roseway Bank	1	600	18										
By Canadian vessels:													
La Have Bank	2	695	24			200	2			4,693	995		
Western Bank	2									15,589	2,280		
West of 66° W. longitude.													
By American vessels:													
Browns Bank	256	424,562	9,311			252,671	4,104			309,652	56,172		
Georges Bank	706	591,538	14,774			69,725	1,382			842,463	133,964		
Clark Bank	2	2,580	99							684	132		
Fippenies Bank	9	11,750	413			38,385	1,037			1,205	304		
Middle Bank	93	55,880	2,051			94,455	1,954			5,793	1,370		
Jeffreys Ledge	123	515,320	12,940			102,041	2,125			5,498	1,098		
South Channel	740	496,635	12,170			154,232	2,762			116,015	20,588		
Nantucket Shoals	32	6,157	170							1,004	188		
Off Chatham	92	61,418	1,440			24,445	503			11,752	2,866		
Seal Island	1	3,600	54							47	10		
Shore, general	770	392,016	10,327			42,490	608			12,564	2,290		
By Canadian vessels:													
Browns Bank	20	42,635	918			6,895	82			3,353	764		
Georges Bank	22	19,635	413			1,234	17			2,992	827		
South Channel	3	1,600	37							1,456	259		
Total	3,078	2,748,216	67,537			881,288	16,111	800	16	3,808,468	556,592		

LANDED AT GLOUCESTER.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	26	48,055	362			134,195	1,595						
Western Bank	38	44,480	328	20,890	$405	35,855	388	6,800	141	75,840	8,469	975	$95
Quereau Bank	16	2,815	23	3,490	55	13,435	174	2,505	58			100	8
Green Bank	18	825	6	660	10	105	2	1,595	30	2,040	465		
Grand Bank	60	435	3	9,345	146	5,585	79	15,740	308	211,891	20,954	46,726	6,916
St. Peters Bank	6			820	16							495	42
Cape Shore	30	50,120	483	190	3	19,920	275						
The Gully	15	780	7	342	5	9,645	126	880	21			25	2
By Canadian vessels:													
Western Bank	2	1,910	19							47,479	2,374		
Quereau Bank	1			160	3								
Cape Shore	1					2,560	32						
West of 66° W. longitude.													
Browns Bank	53	68,961	531	690	10	187,810	2,310	150	3	19,730	2,934		
Georges Bank	195	130,025	1,008	5,735	108	112,435	1,340	9,240	186	28,060	4,251		
Middle Bank	1			3,930	29								
South Channel	41	12,965	198			23,240	292						
Shore, general	1,558	3,062,584	80,261			31,410	739						
By Canadian vessels: Georges Bank	3	5,450	109	2,055	41	800	16	640	14				
Total	2,073	3,429,405	83,338	48,307	831	576,995	7,368	37,550	761	385,040	39,447	48,321	7,063
LANDED AT PORTLAND.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	4	1,110	6			1,640	16			37,723	4,725		
Western Bank	9									147,427	21,031		
Quereau Bank	9									195,357	29,835		
Misaine Bank	1									27,971	5,033		
Green Bank	1									21,163	5,455		
Grand Bank	17					300	6			501,566	54,926		
Burgeo Bank	2									44,176	5,314		
Cape Shore	7							83	4				
The Gully	10	120	1			150	2			272,712	51,435		
By Canadian vessels:													
La Have Bank	1									11,280	1,083		
Western Bank	10	29,565	233							25,055	3,745		
Grand Bank	1									19,315	1,636		

STATEMENT, BY FISHING GROUNDS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1921—Continued.

Fishing grounds.	Number of trips.	Pollock.				Cusk.				Halibut.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT PORTLAND—continued.													
West of 66° W. longitude.													
By Canadian vessels—Continued.													
Browns Bank	1									27,971	$3,145	110	$13
Georges Bank	25									50,850	5,593		
Cashes Bank	3	310	$4			3,185	$46			3,564	659		
Fippenies Bank	4	2,415	53			5,160	134			2,359	351		
Platts Bank	75	64,563	994			137,166	2,691			16,921	2,812		
Jeffreys Ledge	175	202,674	5,105			217,102	4,688			7,225	1,121		
Shore, general	1,690	414,641	6,458	3,685	$82	236,996	5,986			11,454	2,060		
Total	2,055	715,398	12,854	3,685	82	601,699	13,569	83	$4	1,424,089	199,959	110	13
Grand total	7,206	6,893,019	163,729	51,992	913	2,059,982	37,048	38,433	781	5,617,597	795,998	48,431	7,076

Fishing grounds.	Number of trips.	Mackerel.				Miscellaneous.				Total.				Grand total.	
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.			
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.															
East of 66° W. longitude.															
By American vessels:															
La Have Bank	59					6,938	$1,156			2,303,305	$99,731			2,303,305	$99,731
Western Bank	26					54,690	10,461			1,015,109	101,382	17,155	$604	1,032,264	101,986
Quereau Bank	16									427,581	63,743			427,581	63,743
Green Bank	4									170,016	22,479			170,016	22,479
Grand Bank	34					8,656	1,603			1,251,380	138,127	4,250	185	1,255,630	138,312
St. Peters Bank	3									86,633	15,281			86,633	15,281
Burgeo Bank	1									34,853	5,051			34,853	5,051
Cape Shore	59	1,459,974	$124,065	60,400	$5,244	149,173	29,112			2,255,620	175,773	60,400	5,244	2,316,020	181,017
Gulf of St. Lawrence	1									36,750	1,307			36,750	1,307
Roseway Bank	1									42,800	2,517			42,800	2,517
By Canadian vessels:															
La Have Bank	2									92,778	4,662			92,778	4,662
Western Bank	2									36,139	3,137			36,139	3,137
West of 66° W. longitude.															
By American vessels:															
Browns Bank	256					47,223	1,466			11,174,807	468,691	9,500	333	11,184,307	469,024
Georges Bank	706	12,000	2,865			1,398,553	237,543			32,458,336	1,295,214			32,458,336	1,295,214
Clark Bank	2					40	1			120,344	3,916			120,344	3,916
Fippenies Bank	9					840	40			225,618	10,626			225,618	10,626
Middle Bank	93	2,490	274			20,562	1,787			1,376,037	63,066			1,376,037	63,066
Jeffreys Ledge	123					51,567	1,936			1,740,276	60,301			1,740,276	60,301
South Channel	740					450,881	32,878			40,238,978	1,258,250			40,238,978	1,258,250
Nantucket Shoals	32	107,460	10,329			52,735	1,307			543,541	23,969			543,541	23,969
Off Highland Light	1	6,635	1,041							6,635	1,041			6,635	1,041
Off Chatham	92					17,328	1,106			2,206,715	87,842			2,206,715	87,842
Seal Island	1					70	2			47,842	1,302			47,842	1,302
Shore, general	770	404,727	62,899			2,008,018	72,529			4,664,446	218,772			4,664,446	218,772
By Canadian vessels:															
Browns Bank	20					16,244	174			731,248	20,391			731,248	20,391
Georges Bank	22					46,645	8,836			700,126	27,848			700,126	27,848
South Channel	3					5,360	214			289,411	9,350			289,411	9,350
Total	3,078	1,993,286	201,473	60,400	5,244	4,335,523	402,151			104,277,324	4,183,769	91,305	6,366	104,368,629	4,190,135

STATEMENT, BY FISHING GROUNDS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS.; AND PORTLAND, ME.; BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1921—Continued.

Fishing grounds.	Number of trips.	Mackerel.				Miscellaneous.				Total.				Grand total.	
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.			
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT GLOUCESTER.															
East of 66° W. longitude.															
By American vessels:															
La Have Bank	26									2,000,418	$30,155	11,060	$417	2,011,478	$30,572
Western Bank	38									1,470,250	31,909	1,180,740	46,602	2,650,990	78,511
Quereau Bank	16									246,896	3,848	224,236	8,881	471,132	12,729
Green Bank	18									67,368	1,881	164,821	6,361	232,189	8,242
Grand Bank	60					2,005	$296			399,024	24,866	2,251,803	94,147	2,650,827	119,013
St. Peters Bank	6									2,865	40	515,470	20,095	518,335	20,135
Sambro Bank	1											10,520	410	10,520	410
Burgeo Bank	1											5,755	225	5,755	225
Off Newfoundland	3					[1] 200,000	10,000	[1] 351,400	$9,584	200,000	10,000	351,400	9,584	551,400	19,584
Cape Shore	30			580,500	$39,143	11,528	1,730			324,413	7,421	587,540	39,322	911,953	46,743
Gulf of St. Lawrence	3			5,600	895							5,600	895	5,600	895
The Gully	15									28,890	509	187,562	7,334	216,452	7,843
By Canadian vessels:															
Western Bank	2									101,794	3,669			101,794	3,669
Quereau Bank	1											21,710	881	21,710	881
Cape Shore	1									20,165	364			20,165	364
West of 66° W. longitude.															
Browns Bank	53									3,192,725	54,059	43,205	1,323	3,235,930	55,382
Georges Bank	195									8,338,720	145,308	537,200	21,440	8,875,920	166,748
Middle Bank	1											81,630	3,247	81,630	3,247
South Channel	41									2,631,100	26,069			2,631,100	26,069
South	1	1,830	$128							1,830	128			1,830	128
Shore, general	1,558	243,164	36,606			9,174	338			7,713,391	315,344	525	21	7,713,916	315,365
By Canadian vessels: Georges Bank	3									6,670	133	88,870	3,362	95,540	3,495
Total	2,073	244,994	36,734	586,100	40,038	222,707	12,364	351,400	9,584	26,746,519	655,703	6,269,647	264,547	33,016,166	920,250

LANDED AT PORTLAND.														
East of 66° W. longitude.														
By American vessels:														
La Have Bank	4					365	110			93,998	6,147	3,475	63	97,473	6,210
Western Bank	9					9,871	1,370			157,298	22,401	64,540	3,007	221,838	25,408
Quereau Bank	9					464	93			195,821	29,928	23,190	1,038	219,011	30,966
Misaine Bank	1									27,971	5,033			27,971	5,033
Green Bank	1									21,163	5,455			21,163	5,455
Grand Bank	17					865	160			508,776	55,363	42,803	1,881	551,579	57,244
Burgeo Bank	2									44,176	5,314			44,176	5,314
Cape Shore	7	245,704	20,650	3,000	180	5,111	900			250,815	21,550	3,329	195	254,144	21,745
St Anns Bank	6					48,103	8,422			48,103	8,422			48,103	8,422
The Gully	10									299,157	52,001	63,715	3,032	362,872	55,033
By Canadian vessels:														
La Have Bank	1					1,064	170			14,644	1,270	14,340	717	28,984	1,987
Western Bank	10									1,818,445	40,434	9,020	365	1,827,465	40,799
Grand Bank	1					1,227	258			42,917	2,671			42,917	2,671
St. Anns Bank	1					21,162	2,413			21,162	2,413			21,162	2,413
West of 66° W. longitude.														
Browns Bank	1							600	33	27,971	3,145	710	46	28,681	3,191
Georges Bank	25					131,758	27,297			182,608	32,890	9,180	409	191,788	33,299
Cashes Bank	3									20,764	974			20,764	974
Fippenics Bank	4									46,244	2,015			46,244	2,015
Platts Bank	75					2,115	51			825,719	26,077			825,719	26,077
Jeffreys Ledge	175					22,964	849			1,940,299	71,193			1,940,299	71,193
Shore, general	1,690	250,696	31,307			2,136,262	26,263			6,433,685	200,473	11,393	440	6,445,078	200,913
By Canadian vessels:														
Georges Bank	2					16,080	2,430			16,080	2,430			16,080	2,430
South Channel	1									196,800	3,452			196,800	3,452
Total	2,055	496,400	51,957	3,000	180	2,397,411	70,786	600	33	13,234,616	601,051	245,695	11,193	13,480,311	612,244
Grand total	7,206	2,734,680	290,164	649,500	45,462	6,955,641	485,301	352,000	9,617	144,258,459	5,440,523	6,606,647	282,106	150,865,106	5,722,629

[1] Herring. Other items under "Miscellaneous" include bluebacks, 37,100 pounds, value $363; butterfish, 56,149 pounds, value $5,660; flounders, 2,604,657 pounds, value $111,956, herring, 2,062,140 pounds, value $20,823; rosefish, 27,654 pounds, value $681; salmon, 8 pounds, value $1; shad, 49,490 pounds, value $3,415; sharks, 13,508 pounds, value $263; skates; 7,070 pounds, value $170; smelt, 10,018 pounds, value $1,042; sturgeon, 865 pounds, value $142; swordfish, 1,597,645 pounds, value $318,406; tuna, 1,192 pounds, value $47; tautog, 70 pounds, value $4; wolffish, 126,943 pounds, value $3,954; squid, 212 pounds, value $4; lobster, 114 pounds, value $33; livers, 51,651 pounds, value $577; spawn, 109,155 pounds, value, $7,760; and tongues, salted, 600 pounds, value $33.

STATEMENT, BY MONTHS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, 1921.

[NOTE.—The statistics for 1921 include 72 trips landed by Canadian fishing vessels, 49 at Boston, 7 at Gloucester, and 16 at Portland, amounting to 4,222,319 pounds of fish, value $127,549.]

Months.	Number of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 2½ pounds).				Scrod (1 to 2½ pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.													
January	242	1,292,211	$85,525			840,551	$26,323			31,405	$460		
February	253	4,072,065	119,826			824,528	21,043			21,125	207		
March	247	3,124,647	98,489			765,489	20,687			18,280	145		
April	239	1,552,111	54,772			958,531	24,691			35,035	323		
May	257	1,468,079	63,843			1,337,489	31,419			49,275	391		
June	264	1,578,682	55,339			1,639,961	26,339			23,270	159		
July	283	1,214,334	53,594			1,143,907	28,564			38,295	323		
August	321	1,597,402	67,154	3,850	$173	1,357,908	31,479	400	$12	42,675	300		
September	245	1,078,292	59,354	9,760	390	1,075,365	31,802	6,595	198	73,700	667		
October	276	1,219,918	75,081	9,500	333	1,003,302	33,634			90,060	832		
November	251	722,297	42,478			666,434	18,098			91,750	711		
December	200	519,758	40,449			642,539	22,293			98,245	1,103		
Total	3,078	19,439,796	815,904	23,110	896	12,256,004	316,372	6,995	210	613,115	5,621		
LANDED AT GLOUCESTER.													
January	122	214,045	6,017	7,625	419	265,030	5,467	1,050	53	8,110	88		
February	180	484,770	11,756	14,880	819	27,685	534	3,310	149	100	1		
March	371	2,230,370	55,178	84,055	3,119	203,885	3,600	11,214	398	2,210	25		
April	274	781,680	15,435	141,583	5,663	197,848	2,888	25,455	891	3,815	44	340	$10
May	60	278,076	6,213	143,102	5,638	87,263	1,293	25,613	904	4,815	48	1,205	24
June	80	492,799	9,882	573,506	23,599	545,289	8,308	210,145	7,300	5,035	41	14,405	293
July	63	727,883	16,006	562,320	24,014	939,580	14,398	273,305	10,835	7,030	55	17,430	413
August	74	783,800	17,420	341,242	14,247	850,751	14,241	54,595	1,987	14,175	116	2,540	78
September	65	571,692	12,245	1,040,523	44,673	552,320	8,716	605,245	23,904	10,960	90	40,705	961
October	221	761,248	25,210	448,176	17,971	317,545	4,646	358,055	12,111	12,445	91	29,650	635
November	347	380,028	9,329	72,570	2,926	204,845	3,280	18,797	658	5,685	47	740	18
December	216	70,988	3,403	9,410	400	38,795	631	7,665	216	680	5	250	3
Total	2,073	7,777,379	188,094	3,438,992	143,488	4,230,836	68,002	1,594,449	59,406	75,060	651	107,265	2,435

LANDED AT PORTLAND.													
January	99	91,220	5,056			108,379	2,769			72,724	510		
February	128	71,869	2,849			72,756	1,866			33,403	191		
March	178	113,765	5,101			69,720	2,263			22,498	148		
April	262	183,655	5,487	33,000	1,725	90,607	2,010			38,456	212		
May	239	535,106	15,178	70,705	3,383	81,134	1,661	3,435	52	28,402	160	210	4
June	296	456,451	12,980	78,483	3,459	245,332	4,736	19,206	685	6,706	35		
July	175	258,508	11,056	20,162	1,007	33,235	752			2,703	17		
August	164	237,997	9,863	105	5	14,281	392	110	4	6,615	49	245	5
September	143	83,442	4,334	11,180	503	16,742	532	500	20	8,491	45		
October	196	140,228	8,792	296	15	89,143	2,513	100	4	37,451	222	220	4
November	91	55,079	3,291			60,443	1,660			27,183	165		
December	84	117,879	8,129			132,623	3,419			69,830	370		
Total	2,055	2,345,199	92,116	213,931	10,097	1,014,395	24,573	23,351	765	354,462	2,124	675	13
Grand total	7,206	29,562,374	1,096,114	3,676,033	154,481	17,501,235	408,947	1,624,795	60,381	1,042,637	8,396	107,940	2,448
Grounds east of 66° W. long	508	3,269,723	98,482	3,092,232	130,112	2,340,832	45,040	1,474,473	54,969	55,780	517	99,855	2,281
Grounds west of 66° W. long	6,698	26,292,651	997,632	583,801	24,369	15,160,403	363,907	150,322	5,412	986,857	7,879	8,085	167
Landed at Boston in 1920	3,342	19,004,092	1,177,813			12,007,699	423,265			268,715	4,395		
Landed at Gloucester in 1920	2,381	14,086,065	452,203	1,739,372	98,381	10,409,452	251,643	1,812,117	92,430	133,874	1,692	104,932	4,004
Landed at Portland in 1920	1,883	1,756,850	95,859	76,218	4,487	584,731	22,072	100,311	5,532	155,689	2,478	25,465	1,383

STATEMENT, BY MONTHS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, 1921—Continued.

Months.	Number of trips.	Haddock.						Hake.							
		Large (over 2½ pounds).				Scrod (1 to 2½ pounds).		Large (6 pounds and over).				Small (under 6 pounds).			
		Fresh.		Salted.		Fresh.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.															
January	242	6,538,743	$243,569					25,440	$2,378			153,269	$8,134		
February	253	6,604,744	177,115					23,475	1,803			43,685	2,266		
March	247	3,938,065	152,725					36,735	1,938			74,785	2,422		
April	239	2,702,348	152,288					49,290	1,748			82,860	2,108		
May	257	4,271,976	131,982					27,825	603			48,700	1,071		
June	264	4,313,438	77,336			100	$1	37,900	733			104,775	1,771		
July	283	3,725,489	78,305			250	3	118,314	2,327			129,730	2,796		
August	321	4,800,603	71,889					72,950	1,362			225,470	3,574		
September	245	4,418,200	106,123					15,590	315			241,785	5,692		
October	276	5,557,340	151,102			1,050	19	5,715	143			622,759	11,065		
November	251	4,096,685	157,191			18,700	374	52,505	1,521			470,376	6,079		
December	200	4,252,945	231,323			1,050	11	19,425	1,183			276,544	7,620		
Total	3,078	55,220,576	1,730,948			21,150	408	485,164	16,054			2,474,738	54,598		
LANDED AT GLOUCESTER.															
January	122	175,035	3,416					52,015	3,527						
February	180	473,570	16,667					57,985	5,371						
March	371	1,623,305	71,274					31,905	1,851	790	$14				
April	274	716,370	44,812					14,558	568	215	4				
May	60	429,050	3,903					5,005	96	205	4				
June	80	975,610	7,888	1,415	$28			27,365	342	3,455	69				
July	63	1,363,495	13,571					48,310	483	9,195	173				
August	74	1,506,765	14,868	10,925	110			22,250	223	8,355	151				
September	65	1,214,384	16,721					21,400	219	11,690	222				
October	221	618,810	4,633					143,055	2,461	4,245	67				
November	347	91,150	2,487	2,950	44			152,656	1,810	2,743	41				
December	216	24,695	1,658					15,360	856	1,080	14				
Total	2,073	9,212,239	201,898	15,290	182			591,864	17,807	41,973	759				

LANDED AT PORTLAND.															
January	99	215,421	12,918			798	21	2,555	172			43,856	1,558		
February	128	302,859	14,949			2,161	34	3,667	220			92,951	3,672		
March	178	213,431	12,913			883	14	1,443	79			73,591	2,419		
April	262	896,661	29,467			1,243	17	708	26			105,360	2,295		
May	239	553,070	14,947			360	4	19,580	413			111,114	1,673		
June	296	466,894	9,162					325	7	60	3	42,184	443		
July	175	2,541	152					881	26			17,212	279		
August	164	34,844	1,583			590	7	750	10			27,321	400		
September	143	21,779	1,210			365	2	1,605	34	200	3	27,233	551		
October	196	38,885	2,440			883	9	14,905	362			142,775	1,937		
November	91	62,263	4,032			310	5	12,125	238			103,294	1,638		
December	84	125,394	8,834			1,819	14	1,190	32			95,484	1,805		
Total	2,055	2,934,042	112,607			9,412	127	59,734	1,619	260	6	882,375	18,760		
Grand total	7,206	67,366,857	2,045,453	15,290	182	30,562	535	1,136,762	35,480	42,233	765	3,357,113	73,358		
Grounds east of 66° W. long.	508	3,376,905	87,047	3,015	45	300	6	90,318	1,059	41,338	748	42,540	771		
Grounds west of 66° W. long.	6,698	63,989,952	1,958,406	12,275	137	30,262	529	1,046,444	34,421	895	17	3,314,573	72,587		
Landed at Boston in 1920	3,342	64,720,438	2,476,056			31,450	772	814,450	31,575			1,934,954	65,575		
Landed at Gloucester in 1920	2,381	8,372,231	176,091	28,300	854	193,162	2,384	750,240	22,909	51,182	1,321			455	$9
Landed at Portland in 1920	1,883	1,890,946	82,638	16,143	484	26,807	773	118,612	4,652	1,940	49	1,047,866	27,731	1,657	55

STATEMENT, BY MONTHS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, 1921—Continued.

Months.	Number of trips.	Pollock.				Cusk.				Halibut.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.													
January	242	157,792	$6,372			131,650	$2,909			44,641	$14,147		
February	253	64,366	3,262			52,181	1,435			145,527	32,367		
March	247	64,130	3,068			121,815	2,397			290,810	59,866		
April	239	132,683	3,681			110,442	1,707			391,181	68,666		
May	257	145,090	3,669			48,240	854			251,196	45,281		
June	264	308,755	5,588			33,779	484			428,740	53,728		
July	283	247,347	7,537			34,894	582			517,860	58,778		
August	321	378,919	7,413			29,980	615			575,747	61,881		
September	245	435,042	9,754			35,460	685	800	$16	488,536	56,662		
October	276	454,942	10,331			76,507	1,172			599,728	86,747		
November	251	175,660	3,111			80,840	1,251			25,372	6,065		
December	200	183,490	3,751			125,500	2,020			49,130	12,404		
Total	3,078	2,748,216	67,537			881,288	16,111	800	16	3,808,468	556,592		
LANDED AT GLOUCESTER.													
January	122	245,390	11,759			51,260	710			12,620	1,674		
February	180	237,365	16,038	110	$3	9,565	199	400	12				
March	371	31,155	1,540	587	12	27,090	588	490	13				
April	274	33,066	978	155	3	55,295	705	120	3				
May	60	6,420	91	185	4	5,950	75	1,315	36			5,755	$841
June	80	59,840	552	5,330	106	37,365	486	4,700	109	47,479	2,374	975	95
July	63	51,475	448	19,395	384	178,570	2,241	10,445	196	73,382	7,435	36,256	5,570
August	74	58,270	535	2,115	36	91,310	1,173	8,560	172	155,009	14,896	25	2
September	65	95,300	715	13,050	167	60,640	609	7,335	140	41,113	5,979	5,015	527
October	221	38,460	288	4,070	66	29,650	302	3,820	73	46,287	5,364	195	20
November	347	1,401,544	21,911	3,120	47	26,630	247	365	7	9,150	1,725	100	8
December	216	1,171,120	28,483	190	3	3,670	33						
Total	2,073	3,429,405	83,338	48,307	831	576,995	7,368	37,550	761	385,040	39,447	48,321	7,063
LANDED AT PORTLAND.													
January	99	29,023	1,023			56,608	1,864			1,995	422		
February	128	71,008	3,383			106,447	2,309			50,420	11,169		
March	178	19,736	952			65,690	1,957			127,578	25,946		

April	262	77,698	1,062			83,687	1,740			122,465	22,659		
May	239	110,403	1,182			51,138	835			90,999	17,116		
June	296	46,732	365			17,401	322	83	4	265,565	33,013		
July	175	37,188	713	3,500	78	9,612	285			133,116	14,712		
August	164	46,910	491	100	2	6,309	209			285,371	31,038	110	13
September	143	47,996	715			13,020	470			210,604	23,368		
October	196	109,034	1,279	85	2	95,830	1,500			119,229	18,072		
November	91	57,170	677			44,606	816			2,175	337		
December	84	62,500	1,012			51,351	1,262			14,572	2,107		
Total	2,055	715,398	12,854	3,685	82	601,699	13,569	83	4	1,424,089	199,959	110	13
Grand total	7,206	6,893,019	163,729	51,992	913	2,059,982	37,048	38,433	781	5,617,597	795,998	48,431	7,076
Grounds east of 66° W. long	508	303,105	3,891	35,897	643	318,105	4,232	28,403	578	4,134,985	552,240	48,321	7,063
Grounds west of 66° W. long	6,698	6,589,914	159,838	16,095	270	1,741,877	32,816	10,030	203	1,482,612	243,758	110	13
Landed at Boston in 1920	3,342	3,337,074	122,421			745,627	21,110			2,500,532	496,615	12,000	1,150
Landed at Gloucester in 1920	2,381	4,183,785	118,592	16,780	480	598,230	11,271	5,353	230	107,089	19,598	9,736	1,235
Landed at Portland in 1920	1,883	1,018,007	20,472	5,255	163	505,269	15,451	260	8	1,159,973	223,223		

STATEMENT, BY MONTHS, OF QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, 1921—Continued.

Months.	Number of trips.	Mackerel.				Miscellaneous.[1]				Total.				Grand total.	
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.			
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.															
January	242					415,023	$22,705			9,630,725	$412,522			9,630,725	$412,522
February	253					455,836	18,468			12,307,532	377,792			12,307,532	377,792
March	247					419,115	13,106			8,853,871	354,843			8,853,871	354,843
April	239					218,769	5,777			6,233,250	315,761			6,233,250	315,761
May	257	185,300	$18,551			151,779	3,844			7,984,949	301,508			7,984,949	301,508
June	264	1,386,520	116,109	60,400	$5,244	88,491	4,107			9,944,411	341,694	60,400	$5,244	10,004,811	346,938
July	283	42,721	7,938			575,526	112,820			7,788,667	353,567			7,788,667	353,567
August	321	12,710	2,950			726,481	112,735			9,820,845	361,352	4,250	185	9,825,095	361,537
September	245	2,490	274			496,025	65,412			8,360,485	336,740	17,155	604	8,377,640	337,344
October	276	14,850	2,769			316,668	15,596			9,962,839	388,491	9,500	333	9,972,339	388,824
November	251	343,700	51,733			240,305	12,675			6,984,624	301,287			6,984,624	301,287
December	200	4,995	1,149			231,505	14,906			6,405,126	338,212			6,405,126	338,212
Total	3,078	1,993,286	201,473	60,400	5,244	4,335,523	402,151			104,277,324	4,183,769	91,305	6,366	104,368,629	4,190,135
LANDED AT GLOUCESTER.															
January	122					200,000	10,000			1,223,505	42,658	8,675	472	1,232,180	43,130
February	180					3,000	240			1,294,040	50,806	18,700	983	1,312,740	51,789
March	371									4,149,920	134,056	97,136	3,556	4,247,056	137,612
April	274									1,802,632	65,430	167,868	6,574	1,970,500	72,004
May	60									816,579	11,719	177,380	7,451	993,959	19,170
June	80	1,830	128	566,300	36,511					2,192,612	30,001	1,380,231	68,110	3,572,843	98,111
July	63					5,200	78			3,394,925	54,715	928,346	41,585	4,323,271	96,300
August	74					11,528	1,730			3,493,858	65,202	428,357	16,783	3,922,215	81,985
September	65			2,000	200	2,005	296			2,569,814	45,590	1,725,563	70,794	4,295,377	116,384
October	221	29,947	6,056	12,400	2,294	625	12			1,998,072	49,063	860,611	33,237	2,858,683	82,300
November	347	212,588	30,422	5,400	1,033	349	8			2,484,625	71,266	106,785	4,782	2,591,410	76,048
December	216	629	128					351,400	$9,584	1,325,937	35,197	369,995	10,220	1,695,932	45,417
Total	2,073	244,994	36,734	586,100	40,038	222,707	12,364	351,400	9,584	26,746,519	655,703	6,269,647	264,547	33,016,166	920,250
LANDED AT PORTLAND.															
January	99					6,522	265			629,101	26,578			629,101	26,578
February	128					19,261	620			826,802	41,262			826,802	41,262
March	178					17,318	298			725,653	52,190			725,653	52,190
April	262					7,381	148			1,607,921	65,123	33,000	1,725	1,640,921	66,848

May	239					643,916	4,887			2,225,222	58,056	74,350	3,439	2,299,572	61,495
June	296	257,657	22,224	3,000	180	1,292,515	15,629			3,097,762	98,916	100,832	4,331	3,198,594	103,247
July	175	132,864	14,237			172,164	18,770			800,024	60,999	23,662	1,085	823,686	62,084
August	164	4,580	669			135,022	16,160	600	33	800,590	60,871	1,270	62	801,860	60,933
September	143	15,659	2,693			87,409	12,824			534,345	46,778	11,880	526	546,225	47,304
October	196	60,480	8,418			11,691	730			860,534	46,274	701	25	861,235	46,299
November	91	25,160	3,716			3,856	333			453,664	16,908			453,664	16,908
December	84					356	22			672,998	27,096			672,998	27,096
Total	2,055	496,400	51,957	3,000	180	2,397,411	70,786	600	33	13,234,616	601,051	245,695	11,193	13,480,311	612,244
Grand total	7,206	2,734,680	290,164	649,500	45,462	6,955,641	485,301	352,000	9,617	144,258,459	5,440,523	6,606,647	282,106	150,865,106	5,722,629
Grounds east of 66° W. long	508	1,705,678	144,715	649,500	45,462	521,222	68,254	351,400	9,584	16,159,493	1,006,254	5,824,434	251,485	21,983,927	1,257,739
Grounds west of 66° W. long	6,698	1,029,002	145,449			6,434,419	417,047	600	33	128,098,966	4,434,269	782,213	30,621	128,881,179	4,464,890
Landed at Boston in 1920	3,342	6,008,920	639,544	245,100	20,951	6,927,851	655,327			118,301,802	6,114,468	257,100	22,101	118,558,902	6,136,569
Landed at Gloucester in 1920	2,381	150,285	17,529	762,092	70,658	128,540	6,665	3,097,024	110,157	39,112,953	1,080,577	7,627,343	379,759	46,740,296	1,460,336
Landed at Portland in 1920	1,883	125,324	14,237	2,000	175	4,362,180	108,186			12,752,254	617,772	229,249	12,336	12,981,503	630,108

[1] Includes herring from Newfoundland, 200,000 pounds frozen, value $10,000, and 351,400 pounds salted, value $9,584.

The fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels each year are taken principally from fishing grounds off the coast of the United States. In the calendar year 1921, 85.39 per cent of the quantity and 77.99 per cent of the value of the catch landed by American and Canadian fishing vessels were from these grounds; 4.08 per cent of the quantity and 7.32 per cent of the value, consisting chiefly of cod, halibut, and herring, were from fishing banks off the coast of Newfoundland; and 10.51 per cent of the quantity and 14.67 per cent of the value from fishing grounds off the Canadian Provinces. There was a considerable falling off in the percentage of products from grounds off the Canadian Provinces, but an increase in those from grounds off the United States and Newfoundland. Newfoundland herring constituted less than one-half of 1 per cent of the quantity and value of the fishery products landed at these ports during the year. The herring were taken from the treaty coast of Newfoundland, and the cod, haddock, hake, halibut, and other species from that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds. The catch from each of these regions is given in detail in the following table:

Quantity and Value of Fish Landed by American and Canadian Fishing Vessels at Boston and Gloucester, Mass., and Portland, Me., in 1921, from Fishing Grounds off the Coast of the United States, Newfoundland, and Canadian Provinces.

Species.	United States.		Newfoundland.		Canadian Provinces.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Cod:								
Fresh	42,396,111	$1,368,185	260,366	$6,475	5,449,769	$138,797	48,106,246	$1,513,457
Salted	742,208	29,948	2,877,308	114,839	1,789,252	72,523	5,408,768	217,310
Haddock:								
Fresh	64,019,889	1,958,932			3,377,530	87,056	67,397,419	2,045,988
Salted	12,275	137	65	1	2,950	44	15,290	182
Hake:								
Fresh	4,361,017	107,008	42,080	521	90,778	1,309	4,493,875	108,838
Salted	895	17	32,148	586	9,190	162	42,233	765
Pollock:								
Fresh	6,586,314	159,784	1,260	9	305,445	3,936	6,893,019	163,729
Salted	16,095	270	10,825	172	25,072	471	51,992	913
Cusk:								
Fresh	1,741,877	32,816	5,990	87	312,115	4,145	2,059,982	37,048
Salted	10,030	203	17,335	338	11,068	240	38,433	781
Halibut:								
Fresh	1,482,565	243,748	2,306,722	267,119	1,828,310	285,131	5,617,597	795,998
Salted	110	13	47,221	6,958	1,100	105	48,431	7,076
Mackerel:								
Fresh	1,029,002	145,449			1,705,678	144,715	2,734,680	290,164
Salted					649,500	45,462	649,500	45,462
Herring:								
Fresh	2,062,140	20,823	200,000	10,000			2,262,140	30,823
Salted			351,400	9,584			351,400	9,584
Swordfish: Fresh	1,282,556	260,365	12,753	2,317	302,336	55,724	1,597,645	318,406
Miscellaneous:								
Fresh	3,089,653	135,857			6,203	215	3,095,856	136,072
Salted	600	33					600	33
Total	128,833,337	4,463,588	6,165,473	419,006	15,866,296	840,035	150,865,106	5,722,629

SPECIES.

COD.

In 1921 there was a decrease of 73 vessels in the fishing fleet landing fish at Boston, Gloucester, and Portland as compared with the previous year. There were 23 vessels in the salt-bank fishery, or 3 more

than in the previous year, and 98 in the market fishery, or 13 less than in the previous year. These vessels landed their fares of cod and other ground fish at these ports during the year, and large quantities were also landed by vessels fishing on the shore grounds. The catch of cod landed at these ports during the year was 53,515,014 pounds, valued at $1,730,767, of which 48,106,246 pounds, valued at $1,513,457, were fresh, and 5,408,768 pounds, valued at $217,310, were salted. Cod ranked second in both quantity and value among the various species landed.

HADDOCK.

The catch of haddock for the year ranked first in both quantity and value, exceeding that of cod by 13,897,695 pounds and $315,403. The quantity of haddock landed at these ports by fishing vessels during the year amounted to 67,412,709 pounds, valued at $2,046,170, all of which was fresh except 15,290 pounds salted, valued at $182. These fish were taken chiefly on Browns Bank, Georges Bank, South Channel, off Chatham, and shore grounds, and the greater part of the catch, or 55,241,726 pounds, valued at $1,731,356, was landed at Boston.

HAKE.

The catch of hake amounted to 4,536,108 pounds, valued at $109,603, all landed fresh except 42,233 pounds salted, valued at $765. More than half of the catch was landed at Boston. The yield of this species has been comparatively small in recent years.

POLLOCK.

The catch of pollock amounted to 6,945,011 pounds, valued at $164,642, all landed fresh except 51,992 pounds, valued at $913, salted. The greater part of the catch of this species was taken from Browns Bank, Georges Bank, Jeffreys Ledge, South Channel, and shore grounds, and about one-half of the product was landed at Gloucester.

CUSK.

The catch of cusk was 2,098,415 pounds, valued at $37,829, all landed fresh except 38,433 pounds, valued at $781, salted. There was an increase in the catch of cusk of 243,676 pounds in quantity but a decrease of $10,241 in value as compared with the previous year.

HALIBUT.

The catch of halibut was 5,666,028 pounds, valued at $803,074, all landed fresh except 48,431 pounds salted, valued at $7,076. There was an increase of 1,876,698 pounds in quantity and of $61,253 in value as compared with the previous year. The catch was the largest taken in the past six years. The quantity landed at Boston was 3,808,468 pounds, valued at $556,592; at Gloucester, 433,361 pounds, valued at $46,510; and at Portland, 1,424,199 pounds, valued at $199,972.

MACKEREL.

The total catch of fresh mackerel taken by the American fishing fleet in 1921 was 40,323 barrels, compared with 79,799 barrels in

1920, a decrease of 39,476 barrels. The total catch of salted mackerel was 3,242 barrels, compared with 4,897 barrels the previous year, a decrease of 1,655 barrels. The quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet during the year was 3,384,180 pounds, valued at $335,626, of which 2,734,680 pounds, valued at $290,164, were fresh and 649,500 pounds, valued at $45,462 were salted. These were all landed by American fishing vessels. There was a decrease in the total catch of mackerel landed at these ports of 3,909,541 pounds in quantity and of $427,468 in value, as compared with the previous year.

In 1921 the total catch of mackerel up to July 1 was 33,632 barrels fresh and 3,143 barrels salted, compared with 60,842 barrels fresh and 3,357 salted the previous year. In the southern mackerel fishery the purse-seine vessels had a poor season and the gill-net vessels had only fair success. The fleet numbered about 35 seiners and 125 netters. The first vessels sailed on March 30, which was about a week earlier than in the previous year. The weather was unfavorable for fishing most of the time. The seiners reported seeing more fish in the South than for many years. The first vessel arrived at New York April 7 with 6,000 pounds of fresh mackerel weighing from 1 to 3 pounds each, which sold at 50 cents per pound. These fish were caught in latitude 37.50 in 32 fathoms of water. A large fleet of netters arrived at New York May 23 with about 300,000 pounds of fresh mackerel, which was one of the largest day's receipts at that port in recent years. The weather was good on the Cape Shore, and this fishery was comparatively successful, three vessels making second trips. The fish were caught mostly at night and in small schools. The first arrivals from Cape Shore were on May 31, one vessel having 50,000 pounds and another 75,000 pounds, which sold at 10 cents per pound. The Cape Shore fleet consisted of 27 vessels, which landed 2,160,100 pounds of fresh mackerel and 3,143 barrels of salted mackerel, compared with 30 vessels and 1,290,000 pounds of fresh mackerel and 3,217 barrels of salted mackerel the previous year. The fish averaged large; the fresh sold from 6.6 to 16 cents per pound and the salted from $12 to $13.50 per barrel.

SWORDFISH.

The catch of swordfish amounted to 1,597,645 pounds, valued at $318,406. The number of vessels engaged in this fishery was 66, or 4 more than in the previous year, but there was a decrease in the catch of over 36.89 per cent in quantity and 35.57 per cent in value.

FLOUNDERS.

The catch of flounders in the vessel fishery amounted to 2,604,657 pounds, valued at $111,956, a decrease of 1,033,117 pounds, or 28.39 per cent, in quantity and of $54,939, or 32.91 per cent, in value. The catch taken by boats under 5 tons net tonnage is not included in these statistics.

HERRING.

The catch of herring amounted to 2,613,540 pounds, valued at $40,407. Of this quantity, 2,062,140 pounds, valued at $20,823, were taken off the coast of the United States and landed fresh; and

the remainder, including 200,000 pounds, fresh, frozen, valued at $10,000, and 351,400 pounds, salted, valued at $9,584, were Newfoundland herring.

OTTER-TRAWL FISHERY.

The use of the otter trawl in the New England vessel fisheries began with one steamer at Boston in 1905 and has gradually grown to a fishery of considerable importance. In 1912 there were six specially constructed steamers owned and operated by a company at Boston engaged in this fishery. An otter trawler from New York also landed fish at Boston for several months that year. The catch landed at Boston by these vessels in 1912 amounted to 15,025,150 pounds of fish, of which it is estimated that nearly 14,000,000 pounds were haddock. The otter trawlers landed part of their catch of haddock at Portland, Me., for canning purposes. The fishing was confined chiefly to Georges Bank and South Channel. Several trips were also made to Western Bank.

In 1913 three new steamers were added to the fleet, increasing the number to nine, with one additional vessel from New York occasionally landing at Boston. The number of trips made was 326 and the quantity of fish landed at Boston was 14,366,283 pounds, taken chiefly on Georges Bank and in South Channel. During the spring months a number of trips were taken on Western Bank and part of the catch was landed at Portland, Me.

In 1914 the fishery was conducted on the same grounds as in the previous year. The fleet consisted of nine vessels, in addition to which two vessels from New York operated from Boston part of the year. During the year several vessels began to land their fares regularly at Portland. The number of trips made by otter trawlers was 376, of which 64 were from Georges Bank, 272 from South Channel, and 40 from Western Bank. The quantity of fish landed at Boston by this fleet was 16,921,295 pounds, of which 14,832,950 pounds were haddock. The quantity of fish landed at Portland was 5,830,603 pounds, a large part of which was taken on Western Bank during the spring months.

In 1915 this fishery was carried on by 12 steamers as in the previous year. There were 380 trips landed, of which 105 were from Georges Bank, 248 from South Channel, 26 from Western Bank, and 1 trip from Browns Bank. Western Bank was resorted to in March, April, and May, when haddock were less plentiful on Georges Bank and in South Channel than during the winter months. The year's catch taken by these vessels amounted to 21,116,300 pounds of fish, of which 17,062,732 pounds were haddock. Of the total catch of haddock 39.38 per cent were scrod. With the exception of several trips landed at Portland and an occasional trip at Gloucester, when there was a glut of fresh haddock in the market, the fish caught by otter trawlers were landed at Boston.

In the years immediately following, especially during the war period, there was considerable increase in the number of otter-trawl vessels and also in the number of firms engaging in the otter-trawl fishery. The reciprocal arrangement with Canada, permitting Canadian vessels to land their fares at American ports direct from the fishing grounds, also added a few otter-trawl vessels to the fleet landing fish at Boston, Gloucester, and Portland. In 1919 the otter-

trawl fleet included 25 American and 2 Canadian vessels; in 1920, 41 American and 3 Canadian vessels; and in 1921, 23 American and 3 Canadian vessels. In 1920 otter trawlers landed 646 trips of cod and haddock. The catch of cod was 6,311,389 pounds, valued at $315,434, and of haddock, 51,962,457 pounds, valued at $1,882,748. The haddock taken by otter trawlers amounted to 32.68 per cent of the quantity and 26.71 per cent of the value of the total catch of this species landed by fishing vessels.

In 1921 there were 346 trips landed at Boston, Gloucester, and Portland by otter-trawl vessels, amounting to 30,506,057 pounds of fish, valued at $903,878, which was 20.22 per cent of the quantity and 15.99 per cent of the value of the total catch landed by fishing vessels at these ports. The catch included cod, 2,482,833 pounds, valued at $81,258; haddock, 26,734,893 pounds, valued at $750,312; hake, 241,650 pounds, valued at $4,798; pollock, 255,500 pounds, valued at $7,014; cusk, 892 pounds, valued at $19; halibut, 64,038 pounds, valued at $11,579; and other species, 726,251 pounds, valued at $48,898. The catch by otter trawls consists principally of haddock, which in 1921 amounted to 39.65 per cent of the quantity and 36.66 per cent of the value of the entire catch of this species landed. The greater part of the catch in both years was taken from Georges Bank and South Channel.

The following tables give, by fishing grounds and by months, the catch of cod and haddock landed by otter trawlers at these ports in 1920, the catch of cod, haddock, and other species landed by them in 1921, and the catch of cod, haddock, and hake for various years:

COD AND HADDOCK LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY OTTER TRAWLERS IN 1920.

	Number of trips.	Cod.		Haddock.		Total.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
BY FISHING GROUNDS.							
East of 66° W. longitude.							
La Have Bank	1			10,000	$250	10,000	$250
Western Bank	25	961,265	$33,471	1,997,255	63,736	2,958,520	97,207
Quereau Bank	1	79,415	2,099	19,125	387	98,540	2,486
West of 66° W. longitude.							
Georges Bank	208	2,450,403	153,156	15,972,435	652,834	18,422,838	805,990
South Channel	396	2,775,986	124,980	32,758,942	1,121,445	35,534,928	1,246,425
Nantucket Shoals	15	44,320	1,728	1,204,700	44,096	1,249,020	45,824
Total	646	6,311,389	315,434	51,962,457	1,882,748	58,273,846	2,198,182
BY MONTHS.							
January	70	541,858	43,412	4,507,060	245,160	5,048,918	288,572
February	58	869,780	63,204	4,754,060	233,952	5,623,840	297,156
March	90	1,047,335	54,353	6,495,320	211,508	7,542,655	265,861
April	58	787,570	31,084	3,796,791	129,651	4,584,361	160,735
May	57	770,280	24,974	5,147,055	166,509	5,917,335	191,483
June	59	837,304	27,690	4,722,810	145,777	5,560,114	173,467
July	45	372,941	16,777	3,199,505	96,956	3,572,446	113,733
August	49	302,797	10,316	4,370,013	104,923	4,672,810	115,239
September	44	182,470	7,445	4,466,233	100,279	4,648,703	107,724
October	32	197,320	10,858	3,823,530	96,753	4,020,850	107,611
November	36	204,569	13,053	3,286,575	168,926	3,491,144	181,979
December	48	197,165	12,268	3,393,505	182,354	3,590,670	194,622
Total	646	6,311,389	315,434	51,962,457	1,882,748	58,273,846	2,198,182

FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY OTTER TRAWLERS IN 1921.

	Number of trips.	Cod.		Haddock.		Hake.		Pollock.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
BY FISHING GROUNDS.									
East of 66° W. longitude.									
Western Bank	12	496, 500	$9, 594	1, 565, 955	$36, 925	1, 635	$32	32, 650	$303
West of 66° W. longitude.									
Georges Bank	105	1, 298, 920	46, 246	8, 726, 380	239, 925	17, 115	310	59, 050	2, 474
South Channel	227	685, 563	25, 384	16, 345, 558	471, 680	222, 900	4, 456	163, 575	4, 231
Nantucket Shoals	2	1, 850	34	97, 000	1, 782	....	....	225	6
Total	346	2, 482, 833	81, 258	26, 734, 893	750, 312	241, 650	4, 798	255, 500	7, 014
BY MONTHS.									
January	53	378, 960	22, 963	4, 157, 720	158, 542	5, 435	237	74, 470	3, 149
February	34	354, 176	9, 393	3, 433, 005	81, 656	2, 430	179	12, 295	715
March	5	124, 960	2, 793	662, 450	24, 999	70	2	2, 445	133
April	3	11, 000	232	580, 700	12, 531	....	....	13, 060	110
May	16	255, 785	4, 987	1, 558, 615	33, 507	4, 120	75	12, 180	112
June	28	351, 530	6, 692	2, 630, 603	46, 614	30, 965	426	11, 165	152
July	28	32, 267	1, 159	2, 100, 600	36, 251	63, 570	1, 456	1, 545	54
August	33	82, 755	2, 707	2, 491, 085	33, 768	22, 900	366	2, 890	94
September	26	396, 713	10, 228	1, 993, 120	39, 432	8, 380	147	20, 505	387
October	33	210, 155	6, 985	2, 564, 565	66, 915	27, 200	453	10, 540	187
November	38	151, 965	5, 381	1, 942, 535	73, 423	45, 790	517	36, 850	634
December	49	132, 567	7, 738	2, 619, 895	142, 674	30, 790	940	57, 555	1, 287
Total	346	2, 482, 833	81, 258	26, 734, 893	750, 312	241, 650	4, 798	255, 500	7, 014

	Number of trips.	Cusk.		Halibut.		Miscellaneous.		Total.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
BY FISHING GROUNDS.									
East of 66° W. longitude.									
Western Bank	12	480	$10	4, 332	$689	2, 990	$87	2, 104, 542	$47, 640
West of 66° W. longitude.									
Georges Bank	105	....	....	32, 848	5, 301	285, 198	16, 683	10, 419, 511	310, 939
South Channel	227	412	9	26, 858	5, 589	430, 233	31, 837	17, 875, 099	543, 186
Nantucket Shoals	2	....	....	....	....	7, 830	291	106, 905	2, 113
Total	346	892	19	64, 038	11, 579	726, 251	48, 898	30, 506, 057	903, 878
BY MONTHS.									
January	53	....	....	5, 363	1, 477	53, 757	5, 648	4, 675, 705	192, 016
February	34	....	....	11, 281	3, 054	38, 450	2, 554	3, 851, 637	97, 551
March	5	....	....	962	198	6, 030	349	796, 917	28, 474
April	3	....	....	405	55	....	....	605, 165	12, 928
May	16	480	10	2, 363	439	21, 328	879	1, 854, 871	40, 009
June	28	....	....	6, 770	969	17, 041	946	3, 048, 074	55, 799
July	28	....	....	3, 147	448	25, 705	1, 520	2, 226, 834	40, 888
August	33	....	....	2, 006	248	55, 925	3, 262	2, 657, 561	40, 445
September	26	....	....	13, 674	944	114, 775	6, 032	2, 547, 167	57, 170
October	33	137	4	6, 756	1, 335	131, 972	8, 646	2, 951, 325	84, 525
November	38	175	3	8, 704	1, 712	183, 830	10, 325	2, 369, 849	91, 995
December	49	100	2	2, 607	700	77, 438	8, 737	2, 920, 952	162, 078
Total	346	892	19	64, 038	11, 579	726, 251	48, 898	30, 506, 057	903, 878

Cod, Haddock, and Hake Landed at Boston and Gloucester, Mass., and Portland, Me., by Otter Trawlers in Various Years, 1908 to 1921.

Year.	Trips.	Cod.	Haddock.	Hake.	Year.	Trips.	Cod.	Haddock.	Hake.
	Number.	*Pounds.*	*Pounds.*	*Pounds.*		*Number.*	*Pounds.*	*Pounds.*	*Pounds.*
1908....	44	209,800	1,542,000	46,600	1913....	326	1,667,806	12,488,992	209,485
1909....	47	159,800	1,719,000	74,400	1914....	387	1,149,595	15,383,550	259,913
1910....	59	125,850	2,775,000	46,600	1920....	646	6,311,389	51,962,457	....
1911....	178	564,500	7,367,100	151,700	1921....	346	2,482,833	26,734,893	241,650
1912....	295	1,952,950	12,966,700	105,500					

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT.

The following tables give the catch of cod, haddock, and halibut landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels in 1921, taken from each fishing bank each month by otter trawls and by all other forms of fishing apparatus. The landings include both fresh and salted fish, but the latter have been converted to the equivalent weights of fresh fish in the condition landed.

Vessel Landings of Cod, Haddock, and Halibut at Boston and Gloucester, Mass., and Portland, Me., for Each Month of 1921, Shown by Apparatus and Fishing Banks.

[Salt fish have been reduced to the basis of weights of fresh fish.]

JANUARY.

	Trips.	Cod.		Haddock.		Trips.	Halibut	
BY OTTER TRAWLS.								
East of 66° W. longitude.	*Number.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Western Bank.........	2	12,665	$411	60 290	$1,722	1	180	$51
West of 66° W. longitude.								
Georges Bank..........	36	296,257	19,219	2,980,790	112,182	27	4,282	1,223
South Channel..........	16	70,038	3,333	1,116,640	44,638	8	901	203
Total..............	54	378,960	22,963	4,157,720	158,542	36	5,363	1,477
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank.........	5	215,975	8,798	145,335	5,532	5	2,463	711
Quereau Bank..........	2	9,419	272	....	....	1	4,980	1,441
Cape Shore..............	6	149,535	3,536	23,945	240	....	....	....
Gulf of St. Lawrence...	1	24,750	1,052	12,000	255	....	....	....
West of 66° W. longitude.								
Browns Bank...........	41	992,431	41,562	714,960	22,927	35	34,805	9,157
Georges Bank...........	33	643,200	30,775	1,092,845	34,118	25	6,502	2,034
Fippenies Bank.........	3	23,330	1,804	10,575	692	1	59	24
Middle Bank............	40	135,252	7,516	263,218	13,485	19	1,857	619
Jeffreys Ledge..........	19	52,035	2,027	153,362	8,082	15	1,183	271
South Channel..........	2	10,195	959	25,100	1,454	....	....	....
Nantucket Shoals.......	2	4,010	141	22,215	697	1	55	14
Off Chatham............	10	28,470	1,286	183,800	6,472	6	1,192	320
Shore, general..........	243	272,638	9,996	124,922	7,428	29	796	175
Total..............	407	2,561,240	109,724	2,772,277	101,382	137	53,893	14,766
Grand total......	461	2,940,200	132,687	6,929,997	259,924	173	59,256	16,243

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., FOR EACH MONTH OF 1921, SHOWN BY APPARATUS AND FISHING BANKS—Continued.

FEBRUARY.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
West of 66° W. longitude.	*Number.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Georges Bank	31	311,830	$8,155	2,983,255	$68,316	28	8,870	$2,387
South Channel	5	42,346	1,238	449,750	13,340	5	2,411	667
Total	36	354,176	9,393	3,433,005	81,656	33	11,281	3,054
BY OTHER APPARATUS.								
East of 66° W. longitude.								
Quereau Bank	4	47,406	1,270			2	52,136	12,959
Green Bank						1	21,163	5,455
St. Peters Bank	1	5,059	140			2	62,499	11,386
The Gully	1	12,903	357			1	27,751	5,422
West of 66° W. longitude.								
Browns Bank	1	2,500	75			1	6,177	996
Georges Bank	106	4,770,378	134,819	2,478,299	67,845	65	10,942	3,423
Middle Bank	17	28,990	914	204,370	7,944	10	861	149
Jeffreys Ledge	73	145,334	3,788	469,557	20,482	35	1,490	285
South Channel	5	19,905	534	145,640	4,509	5	258	74
Off Chatham	11	33,750	915	250,550	8,513	9	1,160	274
Shore, general	302	222,593	7,036	401,913	17,816	11	234	59
Total	521	5,288,818	149,848	3,950,329	127,109	142	184,666	40,482
Grand total	557	5,642,994	159,241	7,383,334	208,765	175	195,947	43,536

MARCH.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
East of 66° W. longitude.								
Western Bank	1	27,275	$513	198,400	$7,418	1	279	$55
West of 66° W. longitude.								
Georges Bank	4	97,685	2,280	464,050	17,581	4	683	143
Total	5	124,960	2,793	662,450	24,999	5	962	198
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	2	61,840	2,506	110,450	5,044	2	11,090	2,460
Western Bank	9	29,810	1,062			7	211,581	42,249
Quereau Bank						4	87,346	18,400
The Gully	12	169,376	3,178	155	1	3	85,015	16,813
West of 66° W. longitude.								
Browns Bank	7	332,600	9,859	229,600	8,115	11	8,258	2,115
Georges Bank	107	5,146,646	137,272	1,601,280	50,977	44	10,581	2,726
Middle Bank	13	23,363	839	138,400	6,423	10	572	145
Jeffreys Ledge	28	61,500	1,927	110,150	5,577	7	217	46
South Channel	28	140,307	6,110	843,620	37,362	19	1,377	329
Off Chatham	16	69,470	1,951	393,290	17,312	7	409	110
Shore, general	564	572,452	21,656	1,686,289	81,116	10	980	221
Total	786	6,607,364	186,360	5,113,234	211,927	124	417,426	85,614
Grand total	791	6,732,324	189,153	5,775,684	236,926	129	418,388	85,812

Vessel Landings of Cod, Haddock, and Halibut at Boston and Gloucester, Mass., and Portland, Me., for Each Month of 1921, Shown by Apparatus and Fishing Banks—Continued.

APRIL.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
	Number.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
BY OTTER TRAWLS.								
East of 66° W. longitude.								
Western Bank	3	11,000	$232	580,700	$12,531	2	405	$55
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	9	191,623	4,857	338,955	17,819	9	26,072	4,713
Western Bank	6	249,618	4,461	20,705	532	1	1,530	361
Quereau Bank	1	4,500	105	...	...	1	17,534	2,821
St. Peters Bank	...	...	...	...	...	1	24,134	3,895
Burgeo Bank	1	10,663	222	...	...	1	34,853	5,051
The Gully	4	74,430	1,952	...	...	4	121,302	22,488
West of 66° W. longitude.								
Browns Bank	39	1,072,465	31,122	860,725	47,016	33	36,801	6,844
Georges Bank	57	1,343,731	31,291	165,970	6,045	27	234,997	42,438
Clarkes Bank	1	43,340	1,215	20,200	1,240	1	584	117
Middle Bank	7	21,140	642	45,890	2,620	6	437	72
Platts Bank	13	70,090	1,557	32,220	1,563	4	478	72
Jeffreys Ledge	6	26,505	815	17,740	1,200	1	52	8
South Channel	48	453,476	14,774	1,074,835	63,656	37	8,799	1,288
Nantucket Shoals	3	14,245	283	...	...	2	48	10
Off Chatham	11	98,375	3,568	139,045	10,159	7	497	96
Shore, general	564	538,301	17,055	1,019,637	62,203	20	5,123	996
Total	770	4,212,502	113,918	3,735,922	214,053	155	513,241	91,270
Grand total	773	4,223,502	114,150	4,316,622	226,584	157	513,646	91,325

MAY.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
East of 66° W. longitude.								
Western Bank	4	235,060	$4,228	463,065	$9,984	2	1,516	$235
West of 66° W. longitude.								
South Channel	10	18,875	725	998,550	21,741	3	847	204
Nantucket Shoals	2	1,850	34	97,000	1,782	...	...	...
Total	16	255,785	4,987	1,558,615	33,507	5	2,363	439
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	5	89,090	2,775	60,330	1,613	5	22,672	3,914
Western Bank	4	193,550	4,448	...	...	3	65,767	11,498
Quereau Bank	1	66,937	1,264	...	...	...	...	...
Misaine Bank	...	...	...	...	...	1	27,971	5,033
Grand Bank	2	140,283	2,832	...	...	2	24,833	2,855
The Gully	1	11,040	269	...	...	1	17,508	3,255
West of 66° W. longitude.								
Browns Bank	21	480,033	19,485	463,440	15,449	20	19,499	4,266
Georges Bank	72	1,681,824	47,157	270,485	7,237	52	147,677	27,008
Middle Bank	2	4,765	159	7,500	244	2	860	185
Platts Bank	7	39,865	847	3,350	195	5	4,016	792
Jeffreys Ledge	5	15,955	551	9,390	648	2	146	13
South Channel	81	475,611	16,548	2,663,535	83,549	62	11,589	2,298
Nantucket Shoals	9	82,700	2,378	1,165	21	3	556	107
Off Chatham	5	141,475	2,850	75,000	1,463	5	3,387	600
Shore, general	320	656,114	23,661	141,646	6,910	19	4,861	975
Total	535	4,079,242	125,224	3,695,841	117,329	182	351,342	62,799
Grand total	551	4,335,027	130,211	5,254,456	150,836	187	353,705	63,238

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., FOR EACH MONTH OF 1921, SHOWN BY APPARATUS AND FISHING BANKS—Continued.

JUNE.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
	Number.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
BY OTTER TRAWLS.								
East of 66° W. longitude.								
Western Bank	2	210,500	$4,210	263,500	$5,270	1	1,952	$293
West of 66° W. longitude.								
South Channel	26	141,030	2,482	2,367,103	41,344	18	4,818	676
Total	28	351,530	6,692	2,630,603	46,614	19	6,770	969
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	10	271,350	4,987	59,880	706	7	18,876	2,725
Western Bank	5	609,767	12,078			9	217,832	22,602
Quereau Bank	9	187,586	4,053	79,700	753	5	135,748	17,856
Grand Bank	13	536,305	11,403	134	1	5	122,741	12,366
Sambro Bank	1	20,068	410					
Burgeo Bank						2	44,176	5,314
Cape Shore	27	87,201	1,975	39,680	443	3	3,686	539
The Gully	1	58,760	1,307			1	21,136	3,457
West of 66° W. longitude.								
Browns Bank	43	1,420,263	29,334	302,695	2,504	61	28,437	4,635
Georges Bank	57	1,666,734	37,890	229,486	2,144	1	117,052	14,183
Cashes Bank	1	7,325	101			1	2,217	450
Clarkes Bank	1	3,700	185	48,500	1,005	1	100	15
Fippenies Bank	1	7,985	141	25	1	1	1,692	268
Platts Bank	8	40,859	693	190	11	7	5,736	1,023
Jeffreys Ledge	2	3,370	111					
South Channel	65	706,915	19,900	2,331,655	38,758	60	8,669	1,383
Nantucket Shoals	4	12,800	601	200	6	1	297	46
Off Chatham	2	30,145	859			2	2,355	293
Shore, general	329	683,104	20,435	36,209	1,469	20	6,214	1,086
Total	579	6,354,237	146,463	3,128,354	47,801	187	736,964	88,241
Grand total	607	6,705,767	153,155	5,758,957	94,415	206	743,734	89,210

JULY.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
	Number.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
BY OTTER TRAWLS.								
West of 66° W. longitude.								
South Channel	28	32,267	$1,159	2,100,600	$36,251	16	3,147	$448
BY OTTER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	15	748,264	14,127	240,350	2,371	7	27,910	3,056
Western Bank	11	1,008,247	20,877			5	127,684	13,359
Grand Bank	8	557,844	12,273			8	375,720	38,273
Cape Shore	2	67,380	1,706	1,775	9	2	180	29
West of 66° W. longitude.								
Browns Bank	34	1,402,435	41,569	161,105	2,017	22	86,304	10,060
Georges Bank	108	1,194,381	30,886	227,369	2,481	23	159,644	18,911
Cashes Bank	1	2,520	57			1	175	26
Fippenies Bank	1	6,255	156	20	1	1	106	21
Platts Bank	7	28,989	1,069	290	15	7	5,392	760
Jeffreys Ledge	4	4,130	126	1,410	25	3	207	33
South Channel	52	564,841	19,078	2,278,135	46,956	50	8,200	1,181
Off Chatham	9	57,035	2,309	29,540	580	3	199	35
Shore, general	212	362,326	15,642	51,181	1,325	9	2,002	303
Total	464	6,004,647	159,875	2,991,175	55,780	141	793,723	86,047
Grand total	492	6,036,914	161,034	5,091,775	92,031	157	796,870	86,495

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., FOR EACH MONTH OF 1921, SHOWN BY APPARATUS AND FISHING BANKS—Continued.

AUGUST.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
	Number.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
BY OTTER TRAWLS.								
West of 66° W. longitude.								
Georges Bank	8	38,560	$1,244	510,230	$6,709	3	226	$29
South Channel	25	44,195	1,463	1,980,855	27,059	12	1,780	219
Total	33	82,755	2,707	2,491,085	33,768	15	2,006	248
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	11	333,076	7,720	31,935	319	8	54,216	6,227
Western Bank	2	179,665	3,579	10,800	108	2	46,628	5,642
Green Bank						1	40,933	3,322
Grand Bank	40	737,643	16,417			20	645,169	62,730
West of 66° W. longitude.								
Browns Bank	44	1,669,208	43,843	226,630	2,213	28	76 433	9,152
Georges Bank	124	1,426,089	39,830	589,730	5,900	33	126,984	17,030
Cashes Bank	1	3,170	102	30	1	1	1,172	183
Jeffreys Ledge	12	15,682	439	22,385	939	5	342	49
South Channel	64	752,665	24,783	2,908,360	43,315	63	20,424	2,949
Nantucket Shoals	3	40,200	1,099	670	10	1	20	3
Off Chatham	10	60,770	2,144	39,820	629	7	273	43
Seal Island	1	43,800	1,233	325	3	1	47	10
Shore, general	187	329,173	13,629	43,537	1,252	25	1,750	242
Total	499	5,591,141	154,818	3,874,222	54,689	195	1,014,391	107,582
Grand total	532	5,673,896	157,525	6,365,307	88,457	210	1,016,397	107,830

SEPTEMBER.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
	Number.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
BY OTTER TRAWLS.								
West of 66° W. longitude.								
Georges Bank	19	383,983	$9,591	1,330,525	$22,337	9	11,990	$704
South Channel	7	12,730	637	662,595	17,095	6	1,684	240
Total	26	396,713	10,228	1,993,120	39,432	15	13,674	944
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	7	176,805	3,323	62,905	633	3	7,225	894
Western Bank	13	1,175,198	25,686	105,230	1,252	3	35,286	5,172
Quereau Bank	1	74,371	1,653			2	36,694	4,390
Grand Bank	18	1,664 113	36,084			20	576,245	63,667
St. Peters Bank	2	587,599	12,310			1	990	42
Cape Shore	18	90,031	4,605	4,100	90			
The Gully	5	190,547	4,165			1	50	2
West of 66° W. longitude.								
Browns Bank	6	174,660	7,835	21,850	803	4	2,897	472
Georges Bank	94	1,563,019	55,537	1,206,474	20,529	34	61,006	8,608
Middle Bank	1	148,264	3,218					
Platts Bank	5	15,950	497	4,756	327	3	560	53
Jeffreys Ledge	19	27,864	1,476	12,235	637	7	1,106	166
South Channel	45	286,806	13,608	2,122,235	56,690	39	13,489	1,993
Nantucket Shoals	3	43,545	1,938	1,400	23			
Off Chatham	6	34,980	1,475	107,630	3,166	6	496	61
Shore, general	162	105,853	4,796	12,793	474	11	565	72
Total	405	6,359,605	178,206	3,661,608	84,624	134	736,609	85,592
Grand total	431	6,756,318	188,434	5,654,728	124,056	149	750,283	86,536

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., FOR EACH MONTH OF 1921, SHOWN BY APPARATUS AND FISHING BANKS—Continued.

OCTOBER.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
West of 66° W. longitude.	*Number.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Georges Bank	5	82,840	$3,030	231,265	$3,898	5	1,932	$219
South Channel	26	127,315	3,955	2,333,300	63,017	22	4,824	1,116
Total	31	210,155	6,985	2,564,565	66,915	27	6,756	1,335
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	14	273,632	10,172	232,805	5,182	12	9,163	1,779
Western Bank	7	318,093	9,506	18,345	167	3	47,559	5,613
Quereau Bank	8	82,575	2,212			8	231,995	33,095
Green Bank	15	330,894	6,826			3	129,083	19,157
Grand Bank	10	773,520	14,384			8	289,096	38,681
St. Peters Bank	1	373,099	7,130					
Cape Shore	2	32,720	2,283	550	22	1	122	43
West of 66° W. longitude.								
Browns Bank	30	723,093	31,029	216,217	3,519	17	29,479	6,688
Georges Bank	35	727,144	23,887	616,375	8,342	17	10,489	1,719
Fippenies Bank	2	15,315	759	2,115	152	1	405	41
Platts Bank	22	93,920	4,239	10,055	604	6	223	29
Jeffreys Ledge	46	168,700	6,500	54,857	2,143	18	3,896	625
South Channel	85	517,829	28,766	2,483,268	70,137	53	6,502	1,273
Nantucket Shoals	4	42,245	2,257	1,115	25	2	28	8
Shore, general	373	612,516	25,159	16,701	995	15	838	117
Total	654	5,085,295	175,109	3,652,403	91,288	164	758,878	108,868
Grand total	685	5,295,450	182,094	6,216,968	158,203	191	765,634	110,203

NOVEMBER.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
West of 66° W. longitude.								
Georges Bank	3	77,345	$2,182	196,265	$6,802	3	4,495	$532
South Channel	32	74,620	3,199	1,746,270	66,621	27	4,209	1,180
Total	35	151,965	5,381	1,942,535	73,423	30	8,704	1,712
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	9	161,926	4,061	96,010	2,145	4	797	186
Western Bank	1	23,090	393			1	100	25
Quereau Bank	4	201,321	4,038	9,737	71	1	200	8
Green Bank	3	27,170	736			1	2,040	465
Cape Shore	9	167,580	4,269	55,825	1,715	4	389	121
Roseway Bank	1	39,300	2,338	2,900	161			
West of 66° W. longitude.								
Browns Bank	24	459,521	16,931	277,855	11,243	18	13,007	2,956
Georges Bank	18	255,025	8,025	267,970	8,184	12	3,330	822
Fippenies Bank	2	12,555	657	9,150	549	1	156	21
Middle Bank	6	21,545	980	32,815	1,256	3	518	85
Platts Bank	9	29,900	1,596	7,680	521	4	421	71
Jeffreys Ledge	30	91,793	3,534	60,318	3,848	18	1,903	334
South Channel	63	400,311	18,303	1,384,885	55,051	33	4,929	1,192
Off Chatham	3	19,005	1,539	36,725	1,639	1	185	93
Shore, general	469	327,552	9,880	90,780	4,327	5	218	44
Total	651	2,237,594	77,280	2,332,650	90,710	106	28,193	6,423
Grand total	686	2,389,559	82,661	4,275,185	164,133	136	36,897	8,135

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., FOR EACH MONTH OF 1921, SHOWN BY APPARATUS AND FISHING BANKS—Continued.

DECEMBER.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
West of 66° W. longitude.	*Number.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Georges Bank	1	10,420	$515	30,000	$2,100	1	370	$64
South Channel	48	122,147	7,193	2,589,895	140,574	21	2,237	636
Total	49	132,567	7,738	2,619,895	142,674	22	2,607	700
BY OTHER APPARATUS.								
East of 66° W. longitude.								
La Have Bank	3	36,915	1,911	49,075	2,839	2	759	348
Western Bank						1	12,710	1,827
Quereau Bank	1	1,975	99			1	6,445	997
Grand Bank	1	3,150	76			1	7,489	1,418
St. Peters Bank	2	22,540	481					
Cape Shore	5	114,141	4,798	3,850	150	1	23	7
West of 66° W. longitude.								
Browns Bank	39	636,818	29,196	891,060	46,521	36	18,829	5,687
Georges Bank	3	37,230	2,086	82,395	4,354	3	2,313	432
Fippenies Bank	4	24,575	1,545	12,655	751	3	1,146	280
Middle Bank	7	23,080	1,072	44,135	2,552	5	688	115
Platts Bank	4	22,125	1,184	10,150	896	4	95	12
Jeffreys Ledge	53	262,546	10,123	188,143	11,587	28	2,181	389
South Channel	24	150,165	7,309	322,595	18,330	20	6,382	1,298
Nantucket Shoals	1	9,285	566					
Off Chatham	9	45,545	2,798	117,225	6,698	8	1,598	941
Shore, general	292	201,924	9,439	64,725	4,488	11	437	60
Total	448	1,592,014	72,683	1,786,008	99,166	124	61,095	13,811
Grand total	497	1,724,581	80,421	4,405,903	241,840	146	63,702	14,511

TOTAL, JANUARY TO DECEMBER.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTTER TRAWLS.								
East of 66° W. longitude.								
Western Bank	12	496,500	$9,594	1,565,955	$36,925	7	4,332	$689
West of 66° W. longitude.								
Georges Bank	107	1,298,920	46,246	8,726,380	239,925	80	32,848	5,301
South Channel	223	685,563	25,384	16,345,558	471,680	138	26,858	5,589
Nantucket Shoals	2	1,850	34	97,000	1,782			
Total	344	2,482,833	81,258	26,734,893	750,312	225	64,038	11,579
BY OTHER APPARATUS								
East of 66° W. longitude.								
La Have Bank	90	2,560,496	65,237	1,428,030	44,203	64	181,243	27,013
Western Bank	58	3,787,038	82,090	155,080	2,059	35	766,677	108,348
Quereau Bank	31	676,090	14,966	89,437	824	25	573,078	91,967
Misaine Bank						1	27,971	5,033
Green Bank	18	358,064	7,562			6	193,219	28,399
Grand Bank	93	4,412,858	93,469	134	1	64	2,041,293	219,990
St. Peters Bank	6	988,297	20,061			4	87,623	15,323
Sambro Bank	1	20,068	410					
Burgeo Bank	1	10,663	222			3	79,029	10,365
Cape Shore	69	708,588	23,172	129,725	2,669	11	4,400	739
Gulf of St. Lawrence	1	24,750	1,052	12,000	255			
The Gully	24	517,056	11,228	155	1	11	272,762	51,437
Roseway Bank	1	39,300	2,338	2,900	161			

VESSEL LANDINGS OF COD, HADDOCK, AND HALIBUT AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., FOR EACH MONTH OF 1921, SHOWN BY APPARATUS AND FISHING BANKS—Continued.

TOTAL, JANUARY TO DECEMBER—Continued.

	Trips.	Cod.		Haddock.		Trips.	Halibut.	
BY OTHER APPARATUS—continued.								
West of 66° W. longitude.	*Number.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Browns Bank	329	9,366,027	$301,840	4,366,137	$162,327	286	360,926	$63,028
Georges Bank	814	20,455,401	579,455	8,828,678	218,156	336	891,517	139,334
Cashes Bank	3	13,015	260	30	1	3	3,564	659
Clarks Bank	2	47,040	1,400	68,700	2,245	2	684	132
Fippenies Bank	13	90,015	5,062	34,540	2,146	8	3,564	655
Middle Bank	93	406,399	15,340	736,328	34,524	55	5,793	1,370
Platts Bank	75	341,698	11,682	68,691	4,132	40	16,921	2,812
Jeffreys Ledge	297	875,414	31,417	1,099,547	55,168	139	12,723	2,219
South Channel	562	4,479,026	170,672	18,583,863	519,767	441	90,613	15,258
Nantucket Shoals	29	249,030	9,263	26,765	782	10	1,004	188
Off Chatham	91	619,020	21,694	1,372,625	56,631	61	11,752	2,866
Seal Island	1	43,800	1,233	325	3	1	47	10
Shore, general	4,017	4,884,546	178,384	3,690,333	189,803	185	24,018	4,350
Total	6,719	55,973,699	1,649,509	40,694,023	1,295,858	1,791	5,650,421	791,495
Grand total	7,063	58,456,532	1,730,767	67,428,916	2,046,170	2,016	5,714,459	803,074

VESSEL FISHERIES AT SEATTLE, WASH.

In the vessel fisheries at Seattle, Wash., there has been a decrease in the total quantity and value of products landed by the fishing fleet but an increase in the quantity, with a decrease in the value, of products landed by collecting vessels, as compared with the previous year. The decrease in the products landed by the fishing fleet was due chiefly to a decrease in the catch of halibut. There was an increase in the catch of sablefish, but some decrease in that of "lingcod" and rockfishes. Statistics of the vessel fisheries at Seattle have been collected by the local agent and published as monthly and annual statistical bulletins, giving the quantity and value of fishery products landed by American fishing and collecting vessels at that port.

In 1921 the fishing fleet at Seattle landed 866 trips, amounting to 13,666,700 pounds of fish, having a value to the fishermen of $1,423,303. This catch was taken from fishing grounds along the coast from Oregon to Portlock Bank, Alaska. The fishing areas from which the largest quantities of fish were obtained were Flattery Banks, west coast of Vancouver Island, and Hecate Strait. The products included halibut, 11,481,000 pounds, valued at $1,335,658; sablefish, 1,519,400 pounds, valued at $63,685; "lingcod," 463,300 pounds, valued at $16,391; and rockfishes 203,000 pounds, valued at $7,569. Compared with the previous year there was an increase of 44 trips by fishing vessels, but a decrease of 688,750 pounds, or 4.79 per cent, in the quantity and of $569,456, or 28.57 per cent, in the value of the products landed. There was a decrease in the catch of halibut of 1,202,450 pounds, or 9.48 per cent, in quantity and of $578,191, or 30.21 per cent, in value. The catch of "lingcod" decreased 49,735 pounds, or 9.69 per cent, in quantity and $4,762, or 22.51 per cent, in value; and the catch of rockfishes decreased

5,765 pounds, or 2.76 per cent, in quantity and $225, or 2.88 per cent, in value. There was an increase in the catch of sablefish of 569,200 pounds, or 59.90 per cent, in quantity and of $13,722, or 27.46 per cent, in value.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 12,428,525 pounds, valued at $778,878. These products included salmon, 10,349,700 pounds, valued at $679,171; herring, 560,000 pounds, valued at $4,340; steelhead trout, 90,260 pounds, valued at $10,353; smelt, 370,805 pounds, valued at $24,081; perch, 60,400 pounds, valued at $3,476; rockfishes, 147,480 pounds, valued at $9,712; "lingcod," 32,000 pounds, valued at $1,650; flounders, 106,500 pounds, valued at $2,086; sole, 207,080 pounds, valued at $6,724; and crabs, 504,300 pounds, valued at $37,285. Compared with the previous year there was an increase in the products landed by collecting vessels of 2,614,559 pounds, or 26.64 per cent, in quantity, but a decrease of $102,188, or 11.59 per cent, in value.

QUANTITIES AND VALUES OF CERTAIN FRESH FISHERY PRODUCTS LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS, CALENDAR YEAR 1921.

	Number of trips.	Halibut.		Sablefish.	
BY FISHING GROUNDS.		*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oregon coast	5	105,400	$14,173	21,200	$860
Flattery Banks	326	2,635,600	325,913	791,000	32,610
West coast, Vancouver Island	299	3,101,000	385,272	620,200	26,285
Queen Charlotte Islands grounds	19	367,900	57,481	26,500	1,420
Hecate Strait	186	4,158,600	413,107	18,500	800
Forrester Island grounds	2	58,000	5,695	40,000	1,600
Coronation Island	3	68,000	7,683		
Cape Fairweather grounds	4	96,000	12,000	1,000	50
Yakutat grounds	20	786,500	103,984	1,000	60
Portlock Bank	2	104,000	10,350		
Total	866	11,481,000	1,335,658	1,519,400	63,685
BY MONTHS.					
January	11	377,000	61,533	8,500	510
February	40	560,900	82,851	51,700	3,065
March	65	702,900	97,588	32,000	1,510
April	99	1,083,000	154,049	8,000	430
May	139	1,685,500	182,353	19,200	925
June	118	1,387,800	156,772	129,500	5,975
July	80	1,406,500	134,461	91,000	3,660
August	85	1,664,800	146,240	103,500	4,140
September	87	1,183,200	115,954	508,500	21,105
October	80	699,600	115,508	484,000	19,000
November	49	491,800	61,534	72,000	2,840
December	13	238,000	26,815	11,500	525
Total	866	11,481,000	1,335,658	1,519,400	63,685

QUANTITIES AND VALUES OF CERTAIN FRESH FISHERY PRODUCTS LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS, CALENDAR YEAR 1921.—Continued.

	Number of trips.	"Lingcod."		Rockfishes.		Total.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
BY FISHING GROUNDS.							
Oregon coast	5	....	....	....	....	126,600	$15,033
Flattery Banks	326	286,000	$9,980	83,500	$3,162	3,796,100	371,665
West coast, Vancouver Island	299	123,800	4,601	76,500	2,817	3,921,500	418,975
Queen Charlotte Islands grounds	19	2,000	80	1,000	40	397,400	59,021
Hecate Strait	186	43,500	1,410	36,000	1,310	4,256,600	416,627
Forrester Island grounds	2	8,000	320	6,000	240	112,000	7,855
Coronation Island	3	....	....	....	....	68,000	7,683
Cape Fairweather grounds	4	....	....	....	....	97,000	12,050
Yakutat Grounds	20	....	....	....	....	787,500	104,044
Portlock Bank	2	....	....	....	....	104,000	10,350
Total	866	463,300	16,391	203,000	7,569	13,666,700	1,423,303
BY MONTHS.							
January	11	....	....	....	....	385,500	62,043
February	40	22,800	966	11,000	390	646,400	87,272
March	65	27,000	850	16,500	510	778,400	100,458
April	99	74,000	2,050	25,000	720	1,190,000	157,249
May	139	45,500	755	5,000	70	1,755,200	184,103
June	118	8,000	280	6,000	230	1,531,300	163,257
July	80	79,500	3,140	25,500	1,020	1,602,500	142,281
August	85	67,000	2,740	34,500	1,400	1,869,800	154,520
September	87	123,500	5,305	74,000	3,119	1,889,200	145,483
October	80	14,500	290	5,500	110	1,203,600	134,908
November	49	1,500	15	....	....	565,300	64,389
December	13	....	....	....	....	249,500	27,340
Total	866	463,300	16,391	203,000	7,569	13,666,700	1,423,303

FISHERY PRODUCTS, BY MONTHS, TAKEN IN PUGET SOUND AND LANDED AT SEATTLE, WASH., BY COLLECTING VESSELS, 1921.

Species.	January.		February.		March.		April.		May.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Herring	102,000	$510	200,000	$1,000	68,000	$680	60,000	$600	....	....
Salmon:										
Chum or keta	104,000	12,480	....	....	....	....	....	....	....	....
King or spring	16,600	2,292	....	....	....	....	....	....	493,600	$59,232
Miscellaneous	....	....	....	....	....	....	....	....	22,000	2,640
Trout: Steelhead	6,000	720	....	....	....	....	....	....	45,360	5,443
Smelt	48,000	2,880	33,000	2,310	26,540	2,120	18,000	2,160	10,800	1,080
Perch	....	....	8,000	320	11,800	826	18,000	720	....	....
Rockfishes	10,400	416	21,630	1,930	12,000	600	8,000	560	7,000	280
"Lingcod"	5,800	116	16,200	1,134	10,000	400	....	....	....	....
Flounders	....	....	11,500	230	11,500	230	10,000	200	16,500	330
Sole	18,000	540	20,800	624	34,000	1,360	28,000	840	18,000	540
Crabs	66,000	4,500	47,900	3,490	58,520	3,990	61,600	4,200	28,600	1,950
Total	376,800	24,454	359,030	11,038	232,360	10,206	203,600	9,280	641,860	71,495

Species.	June.		July.		August.		September.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Salmon:								
Humpback or pink	....	....	224,000	$4,480	1,351,900	$40,557	311,600	$9,348
Chum or keta	....	....	14,300	429	83,660	2,509	47,850	1,335
King or spring	518,400	$62,218	1,623,000	162,000	977,050	97,765	528,200	47,538
Coho or silver	66,600	7,992	61,000	6,100	185,090	10,500	703,100	35,155
Sockeye or red	64,800	7,128	66,000	3,300	30,940	1,547	....	....
Miscellaneous	21,000	2,310						
Trout: Steelhead	14,500	1,740	11,000	1,110	6,400	640	....	....
Smelt	....	....	....	....	55,865	1,891	33,000	1,320
Rockfishes	12,100	847	16,300	960	11,300	678	10,000	600
Flounders	17,200	250	14,000	180	4,000	80	5,000	250
Sole	14,000	490	17,480	596	12,000	360	12,000	360
Total	728,600	82,975	2,047,080	179,155	2,718,205	156,467	1,650,750	95,906

FISHERY PRODUCTS, BY MONTHS, TAKEN IN PUGET SOUND AND LANDED AT SEATTLE, WASH., BY COLLECTING VESSELS, 1921—Continued.

Species.	October.		November.		December.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Herring			50,000	$750	80,000	$800	560,000	$4,340
Salmon:								
Humpback or pink	11,760	$235					1,899,260	54,620
Chum or keta	1,351,800	25,036					1,601,610	41,789
King or spring	30,650	3,065					4,187,500	434,050
Coho or silver	1,440,800	72,040					2,456,590	131,787
Sockeye or red							161,740	11,975
Miscellaneous							43,000	4,950
Trout: Steelhead	7,000	700					90,260	10,353
Smelt	38,600	2,300	40,000	4,000	67,000	4,020	370,805	24,081
Perch			12,600	910	10,000	700	60,400	3,476
Rockfishes	12,800	1,024	12,350	865	13,600	952	147,480	9,712
"Lingcod"							32,000	1,650
Flounders	6,400	128	4,100	82	6,300	126	106,500	2,086
Sole	8,300	279			24,500	735	207,080	6,724
Crabs	66,440	5,285	85,920	6,755	89,320	7,115	[1] 504,300	37,285
Total	2,974,550	110,092	204,970	13,362	290,720	14,448	12,428,525	778,878

[1] 22,880 dozen.

SMOKED-FISH INDUSTRY OF MAINE, 1921.

Exclusive of a few individuals smoking small quantities of alewives, there were 28 firms engaged in smoking fishery products in Maine in 1921, as compared with 50 firms in 1919.

The quantity of smoked products prepared amounted to 2,624,744 pounds, valued at $259,683, divided as follows: Herring, 2,111,206 pounds, valued at $189,653; finnan haddie, 471,205 pounds, valued at $67,105; and alewives 42,333 pounds, valued at $2,925. As compared with 1919 there has been a decrease of 41 per cent in quantity and 50 per cent in value of smoked fish prepared in the State.

SMOKED FISHERY PRODUCTS OF MAINE, 1921.

Products.	Pounds.	Value.	Products.	Pounds.	Value.
Smoked alewives	42,333	$2,925	Smoked herring—Contd.		
Finnan haddie [1]	471,205	67,105	Medium scale	44,000	$2,770
Kippered herring	78,080	9,148	Boneless	1,005,201	101,780
Smoked herring:			Whole	615,650	43,997
Bloaters	208,050	18,090			
Lengthwise	160,225	13,868	Total	2,624,744	259,683

[1] Includes small quantity of finnan cod.

FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C.[3]

The receipts of fishery products at the Municipal Fish Wharf and Market, Washington, D. C., in 1921 amounted to 9,066,744 pounds, an increase of 492,760 pounds, or 5.43 per cent, as compared with 1920. The five most important products in terms of quantity follow: Squeteagues or "sea trout," 1,956,483 pounds; oysters, 1,926,379 pounds, or 263,805 bushels; river herring, 1,447,192 pounds; shad, 592,337 pounds; and croaker, 581,734 pounds; a total of 6,504,125 pounds, or 71.73 per cent of the entire receipts

[3] Daily reports of the quantity of fishery products received at this market are received by the bureau for tabulation through the courtesy of the Health Department of the District of Columbia.

at this market. These were the five most important species in 1919 and 1920, representing 69.49 per cent and 70.65 per cent of the total receipts, respectively. The increase in receipts as compared with the previous year appears to confirm the slight improvement reported over conditions existing in 1920. The following fishes are usually abundant in the Washington (D. C.) markets: Bass, butterfish, carp, catfish, croaker, flounders, haddock, river herring, mackerel, perch, shad, spot, squeteagues or "sea trout," striped bass, whiting, oysters, and crabs, including crab meat.

Fishery Products, in Pounds, Received at Municipal Fish Wharf and Market, Washington, D. C., 1921.

Species.	January.	February.	March.	April.	May.	June.	July.
Bass, black and sea	48,526	29,981	12,683	1,200	10,600	14,600	3,872
Bluefish	600	400				3,800	500
Bowfin			400				
Butterfish	100	100		3,550	12,800	30,000	27,160
Carp	15,511	13,085	13,596	14,978	10,050	18,248	11,385
Catfish	6,583	15,564	45,712	17,794	10,590	20,730	12,875
Cod	4,100	9,050	4,900	5,350	1,550	3,700	200
Crappie	600	4,300					
Crevallé	200	100					
Croaker	7,100	6,157	122,032	77,465	43,300	118,480	98,100
Dace	80						
Eels	200	108	2,603	1,624	1,775	840	50
Flounders	27,500	27,093	52,336	11,080	15,825	29,122	7,800
Gizzard shad			150				
Haddock	10,450	22,850	50,725	3,350	5,650	1,150	
Hake	2,550	1,100	200				100
Halibut	10,360	5,650	6,017	5,060	10,350	19,450	11,175
Herring, river	27,565	42,911	146,954	707,037	252,125	600	
Hickory shad or "jacks"	200	400	5,974	3,685			
Kingfish				3,400			
Mackerel	5,400	10,100	18,200	600	7,900	16,850	7,600
Mullet	388	4,071	1,313				
Perch	30,049	33,139	56,868	13,369	8,250	5,051	1,700
Pike or pickerel	2,805	2,985	2,141				150
Pollock	1,500	1,405		1,300	600	200	
Redfish or red drum	360		500			600	
Salmon	600				1,000	500	5,000
Scup or porgy		1,000				400	2,500
Shad	30,101	13,713	156,015	360,254	24,508	746	
Sharks	200						
Sheepshead		100					
Smelt	1,345	575					
Spot		200	600			900	1,900
Squeteagues or "sea trout"	84,388	16,150	6,610	132,120	418,105	239,650	287,400
Striped bass	1,240	3,588	90,841	18,459	9,752	16,320	14,335
Sturgeon					266	138	
Sunfish			400				
Tilefish	450	5,875	2,115	1,325	700	3,725	1,550
Tullibee	210	375	230				
Whitefish	100	500					
Whiting						3,000	
Clams, hard [1]	5,152	10,560	7,936	3,264	7,296	11,776	10,656
Oysters: [1]							
In the shell	93,961	180,649	115,920	38,052	336		
Opened	75,745	51,364	35,021	13,299			
Scallops		196	880				
Crabs				2,409		27,150	53,220
Crab meat	2,620	2,600	375	2,380	3,560	12,835	18,720
Frogs			500				
Lobsters			200				140
Shrimp	525	1,650	300		800	100	
Turtles				149			
Total	499,364	519,644	961,247	1,442,553	857,688	600,661	578,088

Fishery Products, in Pounds, Received at Municipal Fish Wharf and Market, Washington, D. C., 1921—Continued.

Species.	August.	September.	October.	November.	December.	Total.
Bass, black and sea	7,950	4,600	4,470	13,200	14,800	166,482
Bluefish	5,650	22,350			600	33,900
Bowfin						400
Butterfish	48,290	42,300	27,450	21,000	13,200	225,950
Carp	3,780	9,825	8,560	5,275	10,595	134,888
Catfish	5,550	11,100	18,200	28,400	32,625	225,723
Cod	800	600	1,000	3,400	7,700	42,350
Crappie					800	5,700
Crevallé						300
Croaker	72,700	12,200	8,600	8,900	6,700	581,734
Dace						80
Eels					6,230	13,430
Flounders	12,600	12,400	10,100	5,700	19,300	230,856
Gizzard shad					1,500	1,650
Haddock	200	1,300	1,200	1,800	1,900	100,575
Hake			9,800	64,700	19,800	98,250
Halibut	12,400	16,200	11,500	19,000	18,500	145,662
Herring, river			60,000	90,000	120,000	1,447,192
Hickory shad or "jacks"						10,259
Kingfish						3,400
Mackerel	4,700	1,900	500	39,800	7,400	120,950
Mullet		800	455	8,100	1,800	16,927
Perch	1,215	2,920	1,000	6,580	14,700	174,841
Pike or pickerel		190	570		3,400	12,241
Pollock		1,000	2,800	5,500	6,300	20,605
Redfish or red drum		100	230			1,790
Salmon	4,300	5,400	8,500	5,400	5,700	36,400
Scup or porgy						3,900
Shad		400	700		5,900	592,337
Sharks						200
Sheepshead						100
Smelt						1,920
Spot	5,000	8,700	21,000	17,000		55,300
Squeteagues or "sea trout"	191,940	171,100	161,320	159,600	88,100	1,956,483
Striped bass	12,860	21,400	21,140	21,100	12,915	243,950
Sturgeon						404
Sunfish						400
Tilefish	400	1,850	1,500	1,700		21,190
Tullibee						815
Whitefish						600
Whiting			12,800	45,600	11,300	72,700
Clams, hard [1]	9,056	6,944	2,496	5,632	3,632	[2] 84,400
Oysters: [1]						
In the shell	399	40,705	183,855	319,200	427,000	[3] 1,400,077
Opened		8,498	70,331	100,031	172,013	[4] 526,302
Scallops				120		1,196
Crabs	40,650	25,875	2,250			151,554
Crab meat	14,975	27,975	8,975	250	250	95,515
Frogs						500
Lobsters						340
Shrimp	200			300		3,875
Turtles	2					151
Total	455,617	458,632	661,302	997,288	1,034,660	9,066,744

[1] The clams have been reduced to pounds on the basis of 8 pounds of meat to a bushel, the oysters on a basis of 7 pounds of meat to a bushel and 8¼ pounds to a gallon.
[2] 10,550 bushels.
[3] 200,011 bushels.
[4] 63,794 gallons.

SHAD AND ALEWIFE FISHERIES OF THE POTOMAC RIVER, 1921.[4]

The number of persons employed in these fisheries in Maryland and Virginia in 1921 was 983, of whom 321 are credited to Maryland and 662 to Virginia. The number of boats in use were 623, valued at $77,150; pound nets, 266, valued at $87,295, of which 68 are credited to Maryland and 198 to Virginia; gill nets 296, valued at $37,565; seines 6, valued at $5,140; and shore and accessory property to the value of $7,735. The total investment amounted to $214,885.

[4] The canvass of these fisheries was made by Winthrop A. Roberts, statistical agent, U. S. Bureau of Fisheries.

The number of shad taken was 405,872, representing 1,160,438 pounds, with a value of $207,370, of which 49,681 shad, or 138,207 pounds, valued at $25,191, are credited to Maryland, and 356,191 shad, or 1,022,231 pounds, valued at $182,179, are credited to Virginia. The falling off of the catch of shad in these States in 1921 as compared with 1920 amounted to 123,486 shad, or 819,342 pounds in quantity and $127,094 in value.

The catch of river herring numbered 10,303,510 fish, or 4,121,404 pounds, valued at $44,041, of which 1,395,000, or 558,000 pounds, valued at $9,010, are credited to Maryland and 8,908,510 river herring, or 3,563,404 pounds, valued at $35,031, to Virginia.

SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER, 1921.

Items.	Maryland.			Virginia.			Total.		
	Number.	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Fishermen	321			662			983		
Row, sail, and houseboats	153		$3,080	219		$9,420	372		$12,500
Gasoline boats	47		11,500	204		53,150	251		64,650
Pound nets	68		9,395	198		77,900	266		87,295
Gill nets	127		17,390	169		20,175	296		37,565
Seines	4		1,140	2		4,000	6		5,140
Shore and accessory property			2,325			5,410			7,735
Total			44,830			170,055			214,885
Shad caught:									
With pound nets	6,320	21,418	4,137	260,581	735,990	127,174	266,901	757,408	131,311
With gill nets	35,761	97,501	17,316	93,950	281,056	54,196	129,711	378,557	71,512
With seines	7,600	19,288	3,738	1,660	5,185	809	9,260	24,473	4,547
Total	49,681	138,207	25,191	356,191	1,022,231	182,179	405,872	1,160,438	207,370
Alewives caught:									
With pound nets	[1] 1,115,000	446,000	7,010	8,383,060	3,353,224	29,956	[1] 9,498,060	3,799,224	36,966
With gill nets	80,000	32,000	800	365,450	146,180	4,115	445,450	178,180	4,915
With seines	200,000	80,000	1,200	160,000	64,000	960	360,000	144,000	2,160
Total	1,395,000	558,000	9,010	8,908,510	3,563,404	35,031	10,303,510	4,121,404	44,041

[1] Includes 30,000 alewives salted by the fishermen, weighing 12,000 pounds, and valued at $300.

BRIEF REVIEW OF THE SHAD FISHERY OF THE POTOMAC RIVER.

INTRODUCTION.

The perpetuation of the important shad fisheries of the Atlantic coast is a matter of concern to many of our fishermen. Beginning with 1915 the bureau has made an annual canvass of the shad fishery of the Hudson River, a river in which practically no fish-cultural operations have been practiced. Beginning with 1919 the bureau began a similar canvass of the shad fishery of the Potomac River, a river in which the propagation of shad has been conducted on a considerable scale for many years. In this connection it will be of interest to review the history of the Potomac River fishery briefly in so far as there are available data. In Figure 4 the catch of shad in the river is shown. The figures used for the period 1866 to 1880, inclusive, are based on an unpublished graph in the bureau's files that is believed to be sufficiently authentic as an index of the trend of the fishery to warrant publication, and those for later years are the re-

sults of actual canvasses of the fisheries given for such years as they were taken. In addition to this, a curve of the number of shad inspected in the District of Columbia from 1873 to 1920, inclusive, is also shown in Figure 4. For the period 1873 to 1896 Stevenson[5] states these represent from 50 to 75 per cent of the total yield of the river.

From the following table of the number of shad inspected in the District of Columbia from 1897 to 1920, inclusive, it will be observed that beginning with 1908 there were considerable receipts of fish in January and February, indicating receipts from sources other than the Potomac River. It is believed, however, that the curve furnishes a fairly reliable index of the fluctuations in catch over the period in question, and this is borne out by the closeness with which it follows the curve of the number of shad taken in the river in those years for which statistics are available.

NUMBER OF SHAD INSPECTED IN THE DISTRICT OF COLUMBIA FROM 1897 TO 1920, INCLUSIVE.

Year.	January.	February.	March.	April.	May.	June.	Total.
1897			190,593	182,164	22,794	[1] 1,534	397,085
1898	1	2	34,558	167,690	66,986	2,810	272,047
1899	1		6,451	230,066	43,146	5,157	284,821
1900		5	21,170	170,911	39,817	3,306	235,209
1901			12,656	112,218	46,565	1,507	172,946
1902			2,363	114,727	61,748	2,270	181,108
1903			34,437	108,646	36,989	4,372	184,444
1904			6,615	115,115	15,788	618	138,136
1905		16	5,980	103,829	8,114	829	118,768
1906		3	1,208	66,270	8,856	301	76,638
1907				69,545	48,926	310	118,781
1908	2,587	9,007	65,983	101,272	22,540	25	201,414
1909	1,027	6,190	74,318	14,196	25,849	336	121,916
1910	708	6,948	109,211	123,608	25,152	1,270	266,897
1911	1,354	5,660	80,928	235,025	73,180	68	396,215
1912	34	2,330	53,237	271,256	103,354	1,145	431,356
1913	658	5,898	43,229	108,717	31,503	4	190,009
1914	[2]	[2]	[2]	[2]	[2]	[2]	131,958
1915	[2]	[2]	[2]	[2]	[2]	[2]	126,013
1916	[2]	[2]	[2]	[2]	[2]	[2]	238,518
1917	[2]	[2]	[2]	[2]	[2]	[2]	219,886
1918	[2]	[2]	[2]	[2]	[2]	[2]	188,259
1919	[2]	[2]	[2]	[2]	[2]	[2]	390,590
1920	[2]	[2]	[2]	[2]	[2]	[2]	267,442

[1] Includes 90 shad inspected in October. [2] Monthly records not shown.

HISTORY.

A study of the graph reveals that the fishery for shad in the Potomac has fluctuated greatly. Even in the period from 1866 to 1880 the fluctuations were surprisingly large, the catches for 1867 and 1873 exceeding 1,250,000 fish, with much smaller catches in the intervening years. Following 1873 the catch steadily declined until in 1878 it was only slightly in excess of 160,000 fish. Of this early period it is stated:[6]

The fisheries of this river annually decreased in value and production up to the time of the war. The intermission which then ensued in the fishing operations on

[5] The Shad Fisheries of the Atlantic Coast of the United States, by Charles H. Stevenson, *in* Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1898 (1899), pp. 101 to 269. [See p. 200 for table of fish inspected.]

[6] The Fisheries and Fishery Industries of the United States, by George Brown Goode and associates, Section V, History and Methods of the Fisheries, Vol. 1, 1887, p. 645.

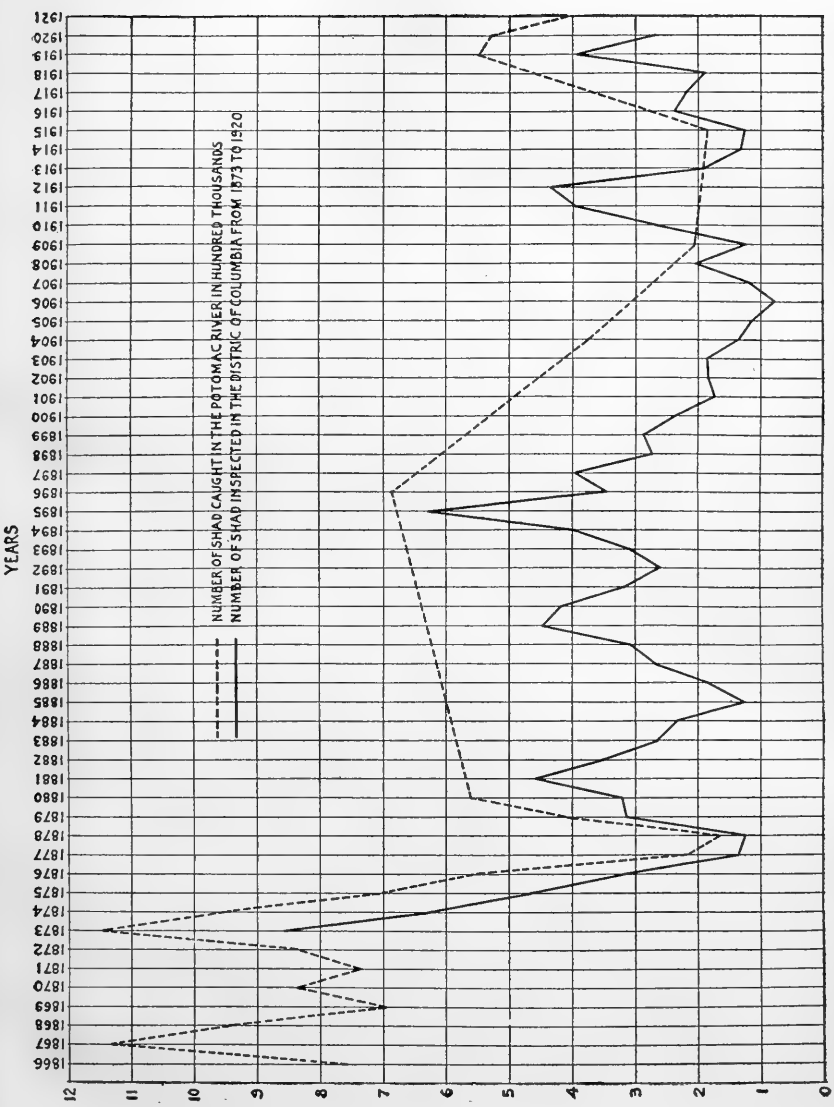

FIG. 4.—Shad fishery of the Potomac River, 1866 to 1921, inclusive. Catch shown in hundred thousands.

account of those of a martial character allowed the fisheries to recuperate, so that in the years immediately succeeding the war it was found that they had in a measure recovered from their former depletion. In 1878, the minimum of production was attained, during which season less than 200,000 shad were taken in the entire river. In 1879 the results of previous artificial propagation first manifested themselves, and there was a considerable increase in the run of shad, from which time the shad fisheries steadily increased, until in the season of 1880 nearly 600,000 were taken.

In the years preceding 1896 Stevenson (ibid., 1898) states that the average annual yield was about 750,000. From 1896 to 1921 statistics of the number of shad caught are available as follows: 1896, 684,063 shad; 1904, 372,647; 1909, 203,971; 1915, 182,402; 1919, 544,469; 1920, 529,358; and 1921, 405,872. Following 1878 it is apparent that the fishery was at a very low ebb in 1885, 1905 to 1907, 1909, 1914, and 1915, with occasional years of relative abundance.

Factors which have contributed to the depletion of the supply are: Intensiveness of fishing operations; changed conditions in the river, resulting from the advance of civilization, productive of conditions in its waters destructive to maintenance of supply of our important anadromous species; and such fluctuations as may be induced by weather conditions affecting the migration of the shad into and up the river. Of the first much has been said and written, of the second relatively little. Some close students of the question suggest that the shad is doomed, that the changed conditions in our rivers resulting from the advance of civilization are steadily growing more unfavorable for reproduction and that it is only a question of time until this important fish disappears from our waters. Certain it is that there is need for further investigations to determine the relative importance of the different factors contributing to the decline of this fishery and the extent to which fish-cultural operations and protective legislation are helping to maintain the supply. Such investigations should include studies of the changes taking place in the rivers and the possibilities of restoring them to a condition favorable to the reproduction and growth of such anadromous fishes. The annual statistical canvasses are being made for the purpose of yielding helpful information to those who may undertake such an investigation.

NOTES ON SPONGE FISHERY.

In 1921 the quantity of sponges sold at the Sponge Exchange, Tarpon Springs, Fla., was 386,390 pounds, valued at $540,093, of which 173,723 pounds, valued at $463,170, were large wool; 63,786 pounds, valued at $28,705, small wool; 70,218 pounds, valued at $30,428, yellow; 65,745 pounds, valued at $12,623, grass; and 12,918 pounds, valued at $5,167, wire. The prices of the small wool sponges were so low in the latter part of 1920 that several thousand bunches were held over for sale in 1921. For this reason the 1921 totals of this kind were larger than for the preceding year. It is estimated that sponges to the value of $40,000 were sold outside of the exchange at Tarpon Springs.

FROZEN FISH.

COLD-STORAGE HOLDINGS DURING 1921.

Beginning with October, 1916, the Bureau of Markets of the Department of Agriculture has been collecting and publishing data on the cold-storage holdings of frozen fish. These reports give the holdings on the 15th day of the current month. Arrangements were made in December, 1921, through the courtesy of the Bureau of Markets and Crop Estimates, for the Bureau of Fisheries to publish and disseminate this information beginning with the returns for Janaury 15, 1922,

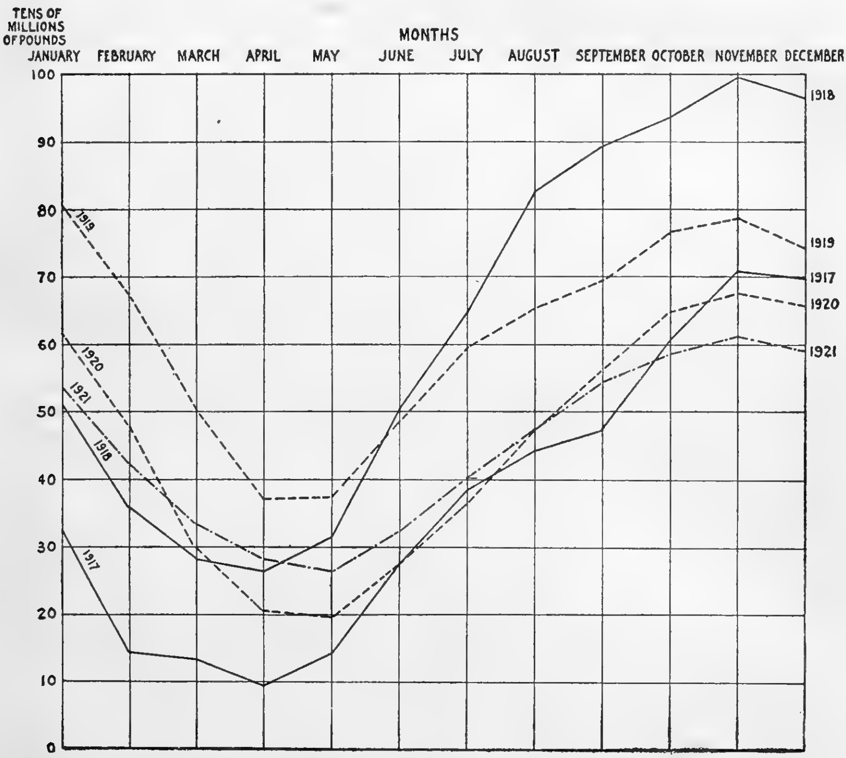

FIG. 5.—Cold-storage holdings of frozen fish in tens of millions of pounds, by months, 1917 to 1921, inclusive.

in the form of a monthly statistical bulletin. This bulletin gives the holdings by species, by sections; total holdings on hand for the current month and for the same month in the preceding year; the 5-year average; holdings for preceding month; and quantities of each species frozen during the month. These bulletins are being distributed on a separate mailing list.

The following table contains a summary of the holdings of frozen fish by species and by months for 1921 and totals for the years 1917 to 1920, inclusive, based on the returns furnished by the Bureau of Markets and Crop Estimates. The total holdings on the 15th of each month for the years 1917 to 1921, inclusive, are shown in graphic form in Figure 5.

Pounds of Frozen Fish in Cold Storage Each Month, by Species for 1921 and by Totals for 1920, 1919, 1918, and 1917.

Species.	Jan. 15.	Feb. 15.	Mar. 15.	Apr. 15.	May 15.	June 15.
1921.						
Bluefish	330,000	237,000	212,000	162,000	126,000	128,000
Butterfish	1,003,000	662,000	355,000	233,000	181,000	153,000
Ciscoes	5,952,000	4,957,000	3,945,000	3,331,000	2,783,000	2,525,000
Cod, hake, pollock, and haddock	3,580,000	3,131,000	2,815,000	2,236,000	1,991,000	1,955,000
Croaker	488,000	406,000	281,000	236,000	219,000	187,000
Halibut	5,961,000	4,117,000	2,526,000	1,965,000	2,773,000	4,375,000
Herring	6,357,000	5,208,000	3,775,000	2,654,000	1,988,000	2,889,000
Lake trout	1,665,000	1,394,000	1,114,000	936,000	896,000	944,000
Mackerel	2,211,000	1,480,000	1,198,000	841,000	675,000	1,695,000
Rockfishes	111,000	102,000	73,000	37,000	47,000	57,000
Sablefish	743,000	389,000	290,000	250,000	208,000	270,000
Salmon	5,607,000	4,419,000	2,777,000	1,900,000	1,466,000	1,621,000
Sea bass	123,000	65,000	50,000	36,000	23,000	28,000
Shad	303,000	161,000	90,000	52,000	77,000	196,000
Shad roe	41,000	34,000	22,000	23,000	18,000	54,000
Smelt, eulachon, etc	171,000	331,000	672,000	304,000	293,000	248,000
Squeteagues	736,000	604,000	336,000	290,000	253,000	263,000
Squid	1,868,000	1,302,000	1,017,000	741,000	1,250,000	3,026,000
Whitefish	1,598,000	1,417,000	1,084,000	1,400,000	1,067,000	985,000
Whiting	5,685,000	3,754,000	2,854,000	2,606,000	2,366,000	2,690,000
Miscellaneous	9,318,000	7,946,000	7,918,000	8,211,000	7,646,000	8,022,000
Total, 1921	53,851,000	42,116,000	33,404,000	28,444,000	26,346,000	32,311,000
Total, 1920	61,510,357	47,904,057	29,958,132	20,632,834	19,803,817	27,779,230
Total, 1919	80,683,761	67,617,473	50,036,475	37,110,856	37,174,104	48,840,359
Total, 1918	51,116,037	35,907,071	28,457,301	26,548,272	31,403,425	50,298,027
Total, 1917	32,234,530	14,727,099	13,374,429	9,516,217	14,040,024	27,791,047

Species.	July 15.	Aug. 15.	Sept. 15.	Oct. 15.	Nov. 15.	Dec. 15.
1921.						
Bluefish	114,000	282,000	442,000	748,000	745,000	667,631
Butterfish	154,000	255,000	422,000	612,000	826,000	664,621
Ciscoes	2,605,000	4,444,000	5,839,000	6,343,000	5,894,000	6,243,839
Cod, hake, pollock, and haddock	1,916,000	1,878,000	1,865,000	1,633,000	1,766,000	1,721,849
Croaker	277,000	331,000	338,000	266,000	219,000	545,788
Halibut	6,213,000	7,693,000	9,129,000	8,486,000	7,995,000	6,868,971
Herring	3,775,000	3,715,000	3,870,000	5,259,000	5,624,000	5,788,866
Lake trout	1,032,000	991,000	1,053,000	1,213,000	2,004,000	2,488,786
Mackerel	1,670,000	1,696,000	1,603,000	1,496,000	1,667,000	1,834,162
Rockfishes	71,000	69,000	69,000	57,000	66,000	28,929
Sablefish	456,000	600,000	977,000	1,619,000	1,624,000	1,486,155
Salmon	3,087,000	4,809,000	7,033,000	8,716,000	9,149,000	7,526,214
Sea bass	56,000	68,000	61,000	56,000	59,000	51,754
Shad	270,000	325,000	349,000	331,000	344,000	287,205
Shad roe	54,000	45,000	43,000	28,000	28,000	26,694
Smelt, eulachon, etc	268,000	272,000	335,000	334,000	317,000	380,396
Squeteagues	1,405,000	1,640,000	1,751,000	2,193,000	2,044,000	1,735,097
Squid	3,170,000	3,177,000	3,017,000	2,855,000	2,581,000	2,151,850
Whitefish	1,278,000	1,587,000	1,782,000	2,022,000	2,360,000	2,614,334
Whiting	4,499,000	4,974,000	5,258,000	5,096,000	5,405,000	4,750,282
Miscellaneous	7,790,000	8,580,000	9,233,000	9,536,000	10,511,000	11,262,223
Total, 1921	40,160,000	47,431,000	54,469,000	58,899,000	61,228,000	59,125,646
Total, 1920	36,617,706	47,140,132	56,295,975	64,730,531	67,549,377	65,841,000
Total, 1919	59,674,301	65,145,234	69,580,555	76,763,253	78,769,101	74,202,339
Total, 1918	64,864,532	82,554,798	89,203,946	93,811,909	99,631,789	96,600,247
Total, 1917	38,431,221	44,024,666	47,197,660	60,676,722	70,938,957	69,986,671

QUANTITIES FROZEN IN 1921.

The quantity of fish frozen between December 15, 1920, and December 15, 1921, was 79,173,892 pounds, as compared with 93,973,589 pounds for the preceding year. The principal varieties frozen were as follows: Halibut, 10,773,803 pounds; salmon, 10,033,619 pounds; herring, 9,827,671 pounds; cicoes, 8,649,315

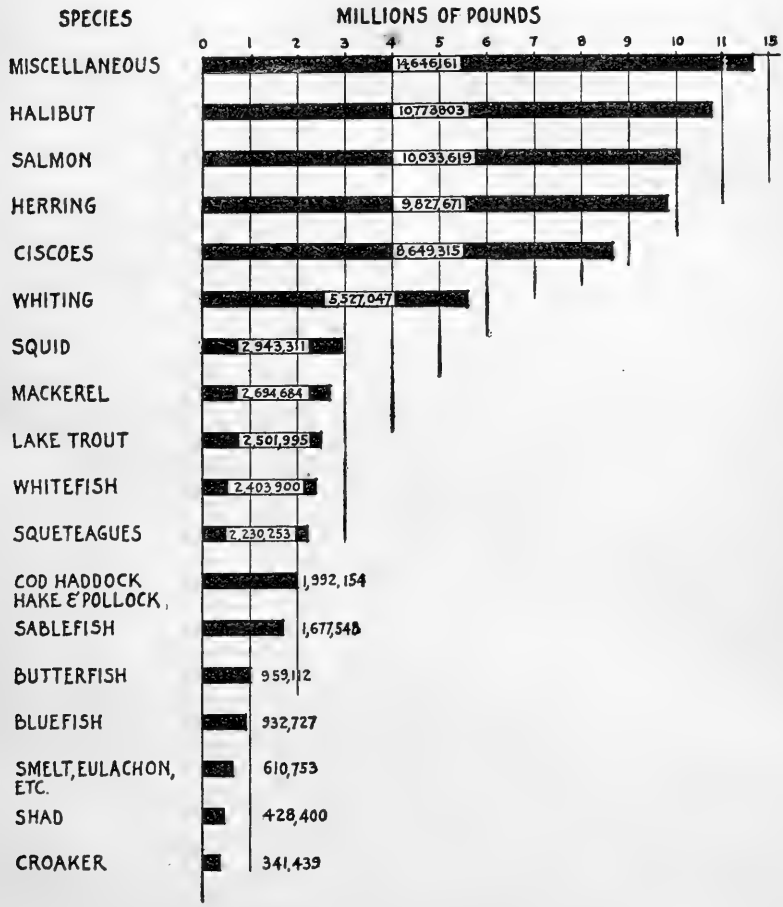

FIG. 6.—Quantities of fish frozen during 1921, by species.

pounds; and whiting, 5,527,047 pounds. The item of miscellaneous fishes amounted to 14,436,657 pounds and includes a large variety of fishery products—true fishes, both mollusks and crustaceans, etc. In Figure 6, which shows the relative amounts of each species, frozen shad roe has been added to the item of shad, and rockfishes, amounting to 77,255 pounds, and sea bass, amounting to 132,249 pounds, have been included in the item of miscellaneous fishes.

POUNDS OF FISH FROZEN MONTHLY, BY SPECIES FOR 1921 AND BY TOTAL FOR 1920.

Species.	Jan. 15.	Feb. 15.	Mar. 15.	Apr. 15.	May 15.	June 15.	July 15.
Bluefish	2,000	1,000	6,000	....	22,000	19,000	186,000
Butterfish	7,000	7,000	....	....	14,000	2,000	108,000
Ciscoes	45,000	38,000	69,000	14,000	61,000	292,000	2,056,000
Cod, hake, pollock, and haddock	172,000	39,000	72,000	47,000	126,000	114,000	88,000
Croaker	2,000	2,000	....	....	11,000	108,000	32,000
Halibut	303,000	153,000	344,000	915,000	2,045,000	1,455,000	1,893,000
Herring	427,000	205,000	89,000	288,000	1,671,000	1,559,000	643,000
Lake trout	81,000	1,000	4,000	31,000	145,000	125,000	33,000
Mackerel	81,000	141,000	94,000	25,000	1,114,000	169,000	242,000
Rockfishes	7,000	....	15,000	10,000	14,000	8,000	5,000
Sablefish	4,000	58,000	52,000	40,000	110,000	66,000	185,000
Salmon	344,000	129,000	60,000	41,000	345,000	1,250,000	1,867,000
Seabass	5,000	....	1,000	....	14,000	33,000	18,000
Shad	1,000	12,000	12,000	5,000	175,000	46,000	56,000
Shad roe	....	....	15,000	3,000	36,000	19,000	....
Smelt, eulachon, etc	253,000	177,000	13,000	....	12,000	....	8,000
Squeteagues	6,000	8,000	4,000	....	44,000	1,194,000	299,000
Squid	19,000	20,000	....	487,000	1,791,000	261,000	273,000
Whitefish	148,000	38,000	136,000	11,000	12,000	272,000	289,000
Whiting	36,00	120,000	3,000	117,000	786,000	2,016,000	599,000
Miscellaneous	900,000	621,000	1,424,000	664,000	1,076,000	1,143,000	965,000
Total 1921	2,843,000	1,770,000	2,413,000	2,698,000	9,624,000	10,151,000	9,845,000
Total 1920	2,273,744	2,630,482	2,465,375	3,687,538	10,094,367	12,761,791	13,620,232

Species.	Aug. 15.	Sept. 15.	Oct. 15.	Nov. 15.	Dec. 15.	Total.
Bluefish	180,000	341,000	91,000	77,000	7,727	932,727
Butterfish	203,000	243,000	347,000	22,000	6,112	959,112
Ciscoes	1,875,000	1,076,000	1,394,000	1,157,000	572,315	8,649,315
Cod, hake, pollock, and haddock	95,000	617,000	286,000	186,000	150,154	1,992,154
Croaker	93,000	....	31,000	61,000	1,439	341,439
Halibut	1,363,000	423,000	872,000	629,000	378,803	10,773,803
Herring	632,000	1,937,000	980,000	1,272,000	124,671	9,827,671
Lake trout	93,000	215,000	910,000	854,000	9,995	2,501,995
Mackerel	105,000	192,000	212,000	201,000	118,684	2,694,684
Rockfishes	4,000	2,000	1,000	8,000	3,255	77,255
Sablefish	339,000	655,000	121,000	34,000	13,548	1,677,548
Salmon	2,182,000	1,892,000	1,637,000	153,000	133,619	10,033,619
Seabass	4,000	9,000	9,000	9,000	30,249	132,249
Shad	28,000	19,000	1,000	....	400	355,400
Shad roe	....	....	....	....	....	73,000
Smelt, eulachon, etc	65,000	16,000	9,000	12,000	45,753	610,753
Squeteagues	190,000	462,000	7,000	3,000	13,253	2,230,253
Squid	53,000	7,000	3,000	18,000	11,311	2,943,311
Whitefish	207,000	357,000	245,000	640,000	48,900	2,403,900
Whiting	464,000	160,000	589,000	441,000	196,047	5,527,047
Miscellaneous	1,181,000	1,367,000	2,124,000	2,396,000	575,657	14,436,657
Total 1921	9,356,000	9,990,000	9,869,000	8,173,000	2,441,892	79,173,892
Total 1920	11,803,606	11,168,810	9,711,800	9,750,844	4,005,000	93,973,589

FISHERIES OF CALIFORNIA IN 1921.

Through the courtesy of the California Fish and Game Commission the bureau has received copies of its monthly sheets showing the catch of fish, by species and by localities, for the calendar year 1921. These have been compiled by species and by months, as shown in the table following the discussion.

In 1921 the catch of the fisheries amounted to 127,728,623 pounds, as compared with 212,635,075 pounds in 1920, a decrease of 84,906,452 pounds, or 39.93 per cent. Following are the principal products: Pilchards, 59,332,305 pounds; albacore and tuna, 19,831,680 pounds; flounders, 8,429,595 pounds; salmon, 7,990,932 pounds; rockfishes, 4,641,156 pounds; barracuda, 4,588,900 pounds; mackerel, 2,914,613 pounds; yellowtail, 2,139,626 pounds; white sea bass or squeteague, 2,069,544 pounds; anchovies, 1,946,881 pounds; abalones, 1,481,170 pounds; bonito or skipjack, 1,376,712 pounds; sablefish, 1,022,556 pounds; and shad, 862,897 pounds.

There was a decrease in the catch of pilchards in 1921 of 59,185,424 pounds, or 49.93 per cent, as compared with 1920. For the same period the decrease in the catch of albacore and tuna amounted to 16,312,660 pounds, or 45.13 per cent; bonito or skipjack, 7,237,869 pounds, or 84 per cent. There was an increase in the catch of anchovies of 1,376,195 pounds, or 241.15 per cent, and of sablefish of 241,524 pounds, or 30.92 per cent, as compared with 1920.

The imports of fresh fish from Mexico in 1921 amounted to 6,699,817 pounds, as compared with 8,121,225 pounds in 1920. The principal species imported were: Barracuda, 3,036,262 pounds; flounders, 1,314,918 pounds; sea crawfish or spiny lobster, 943,547 pounds; and white sea bass or squeteague, 500,075 pounds.

Products, in Pounds, of the Fisheries of California, 1921.

Species.	January.	February.	March.	April.	May.	June.	July.
Albacore and tuna	2,493	332	590	339	972	219,224	5,356,858
Anchovies	50,870		7,755	238,152	394,240	149,052	1,016,987
Barracuda	67,680	135,161	514,378	797,412	1,154,100	781,672	436,230
Bluefish, California, or squeteague	5,259	6,006	7,030	3,265	1,813	6,094	8,394
Bonito or skipjack	12,137	23,177	6,598	104	580	12,429	38,611
Carp	9,864	27,259	28,746	11,364	3,330	3,693	2,925
Catfish	7,511	18,906	40,734	21,913	13,217		
Croakers	335	30,535	26,457	4,663	4,420	1,140	2,084
Flounders	577,948	732,012	717,557	622,260	772,656	739,561	630,231
"Hake"	3,637	3,061	4	3,250	6,837	13,239	13,325
Hardhead	17,617	38,399	5,941	32			
Herring	190,038	233,978	45,564	5,074	120		
Kingfish	44,744	58,389	46,707	57,104	52,533	25,538	7,217
"Lingcod"	22,246	21,478	28,610	25,302	16,895	12,355	35,760
Mackerel	223,401	205,858	361,874	81,422	309,283	221,338	189,732
Mullet			433	6,146	1,796	933	2,353
"Perches," surf	22,234	23,634	50,773	47,534	5,821	4,039	7,820
Pike, Sacramento	1,726	1,888	1,151	846	721	226	
Pilchard	2,302,314	8,706,484	9,945,896	6,014,034	250,793	935,870	990,638
Pompano, California	354	2,652	863	3,431	376	1,167	56
Rockfishes	743,743	586,409	479,778	359,367	201,826	144,502	253,305
Sablefish	28,082	52,290	73,623	163,038	189,126	93,786	94,781
Salmon	14,868	78,913	384,909	522,681	1,063,289	1,441,335	1,500,780
Sculpin	3,862	4,780	5,126	10,392	9,840	3,239	77
Sea bass, black	14,504	7,110	1,566	3,919	6,425	11,656	6,204
Sea basses or "rock bass"	5,677	8,842	18,997	35,604	33,317	54,189	62,317
Sea bass, white or squeteague	4,219	32,520	50,106	251,295	302,910	552,640	252,674
Shad	97	339	42,772	355,026	423,134		272
Sharks	63,904	101,735	88,392	89,635	51,003	47,209	18,122
Sheepshead	2,095	4,167	4,049	7,107	1,960	216	85
Skates	11,164	11,003	3,428	4,565	935	3,883	2,710
"Smelt"	26,936	42,446	93,158	71,508	33,191	42,202	59,271
Split-tail	7,296	4,550	647	46	140		
Striped bass	73,397	41,115	50,430	95,611	104,083		94
Stingarees or stingrays	1,555	203			6,795		
Suckers	410	1,566	85				
Swordfish						332	818
Tomcod	4,151	6,766	4,181	1,681	260	4,549	2,405
Whitebait	31	4	884	654	180	182	116
Whitefish	2,757	2,006	10,332	1,229	901	590	437
Yellowtail	6,781	92,635	95,292	80,130	154,303	91,003	19,827
Other fish	4,786	8,218	13,001	6,687	8,795	88,548	998,466
Crabs	74,514	95,326	65,142	43,516	77,660	28,292	21,912
Shrimps	23,284	36,186	91,384	62,930	90,648	61,685	82,561
Sea crawfish or spiny lobster	34,233	32,261					
Abalones	88,237		163,769	120,216	165,367	135,774	220,515
Clams	40,456	43,054	48,784	47,563	49,687	51,228	43,185
Cockles	3,956	1,883	1,497	1,520	1,058	479	269
Mussels	597	100	590	60			
Oysters:							
Eastern	7,024	5,218	6,743	3,951	3,451	3,482	1,923
Native					2,926	3,614	220
Scallops		300	336	210	252	273	
Octopus	4,471	7,236	10,372	4,959	5,050	3,349	2,147
Squid	22	251	85,538	70,838	105,955	52,846	1,426
Turtles	61			5			
Total	4,859,578	11,578,641	13,732,572	10,359,590	6,084,970	6,048,653	12,386,140

Products, in Pounds, of the Fisheries of California, 1921—Continued.

Species.	August.	September.	October.	November.	December.	Total.
Albacore and tuna	9,876,898	3,684,325	622,901	64,770	1,978	19,831,680
Anchovies	27,325	19,805	26,675	13,825	2,195	1,946,881
Barracuda	188,499	255,245	143,572	82,677	32,274	4,588,900
Bluefish, California, or squeteague	6,247	5,091	13,911	7,366	3,389	73,865
Bonito or skipjack	245,904	880,227	92,046	10,053	54,846	1,376,712
Carp	7,803	379	2,282	1,216	3,265	102,126
Catfish	291	2,283	12,734	15,620	14,907	148,116
Croakers						69,634
Flounders	925,725	729,726	750,528	587,003	644,388	8,429,595
"Hake"	3,660	13,935	13,920	4,245	11,105	90,218
Hardhead			2,106	5,559	6,157	75,811
Herring				217	67,133	542,124
Kingfish	6,801	7,392	15,437	4,560	62,968	389,390
"Lingcod"	82,340	56,960	45,249	29,212	49,136	425,543
Mackerel	296,923	241,878	263,365	202,897	316,642	2,914,613
Mullet	249		3,443	176	1,611	17,140
"Perches," surf	9,419	17,889	14,230	21,157	18,224	242,774
Pike, Sacramento	51	89	275	227	1,920	9,120
Pilchard	7,212,767	6,982,391	5,491,251	6,145,457	4,354,410	59,332,305
Pompano, California	332	579	2,786	1,404	2,333	16,333
Rockfishes	366,031	301,130	434,944	298,167	471,954	4,641,156
Sablefish	136,834	67,612	59,906	19,086	44,392	1,022,556
Salmon	1,661,519	933,198	187,959	173,785	27,696	7,990,932
Sculpin	582	3,677	7,133	7,838	1,522	58,068
Sea bass, black	5,061	4,460	4,100	4,715	17,476	87,196
Sea basses or "rock bass"	47,089	26,254	26,938	24,420	12,058	355,702
Sea bass, white or squeteague	292,128	190,182	37,413	68,799	34,658	2,069,544
Shad	16,072	1,143		17,326	6,716	862,897
Sharks	31,410	6,043	9,904	2,924	29,052	539,333
Sheepshead	173	156	122	1,029	2,766	23,925
Skates	1,218	765	1,835	3,935	14,723	60,164
"Smelt"	66,174	81,302	98,865	83,048	57,637	755,738
Split-tail				49	440	13,168
Steelhead trout			52	777	2,776	3,605
Striped bass	60,425	22,606		64,499	89,356	601,616
Stingarees or stingrays					1,215	9,768
Suckers			313	1,000	784	4,158
Swordfish	8,576	4,344	733			14,803
Tomcod	4,715	4,864	6,338	438	1,431	41,779
Whitebait	751	592	1,602		233	5,229
Whitefish	805	1,313	1,868	3,029	3,372	28,639
Yellowtail	196,451	532,941	549,530	255,776	64,957	2,139,626
Other fish	25,059	8,687	26,585	7,582	43,299	1,239,713
Crabs				96,580	231,264	734,206
Shrimps	87,162	122,866	81,415	110,919	58,794	909,834
Sea crawfish or spiny lobster			84,353	117,433	65,991	334,271
Abalones	155,787	162,553	77,811	147,245	43,896	1,481,170
Clams	38,393	36,488	31,737	32,925	32,439	495,939
Cockles	677	938	316	1,528	383	14,504
Mussels	1,033	1,941	1,427	936	1,527	8,211
Oysters:						
Eastern	3,976	4,527	6,314	6,639	7,789	61,037
Native						6,760
Scallops						1,371
Octopus	1,641	2,361	2,859	4,679	7,142	56,266
Squid	31,217	1,205	6	7,107	76,147	432,558
Turtles			160	75		301
Total	22,132,193	15,422,342	9,259,249	8,761,929	7,102,766	127,728,623

MEXICAN FISHERY PRODUCTS, IN POUNDS, IMPORTED INTO CALIFORNIA, 1921.

Species.	January.	February	March.	April.	May.	June.	July.
Barracuda	559,264	665,346	533,311	12,511		22,844	2,265
Bonito or skipjack	13,358	8,825	404			555	1,035
Croakers		125	170				
Flounders	57,270	119,978	59,185	34,205	79,608	28,847	110,139
Kingfish	315					425	
Mackerel	4,245	24,579	860	1,888		65	743
Mullet	6,475	1,195					
"Perches," surf		3,493	405				
Pompano, California		305					
Rockfishes	11,675	75	1,860		50	12,937	2,010
Sculpin	312						
Sea basses or "rock bass"	2,550	430	115		1,020	775	125
Sea bass, black	9,943	10,585	1,034		100	1,607	2,521
Sea bass, white or squeteague	5,775	16,787	69,445	1,189	6,407	2,853	20,618
"Smelt"	105	390	112	240			170
Tuna	682			59,835	32,169	16,380	1,121
Whitefish	600						
Yellowtail	3,215	82,210	15,369	164	75	7,530	975
Other fish		200					
Sea crawfish or spiny lobster	100,363	100,424	182,492	169,690	148,766		
Abalones		1,190	6,904				
Turtles	145			675		1,015	
Total	776,292	1,036,137	871,666	280,397	268,195	95,833	141,722

Species.	August.	September.	October.	November.	December.	Total.
Barracuda	25,365	56,339	327,249	548,693	283,075	3,036,262
Bonito or skipjack	1,470	435	6,640	12,088	38,208	83,018
Croakers						295
Flounders	300,587	149,862	148,414	177,059	49,764	1,314,918
Kingfish	50		455		450	1,695
Mackerel	276	175	15,425	8,300	4,090	60,646
Mullet				4,040		11,710
"Perches," surf			105	275	5,377	9,655
Pike, Sacramento			875			875
Pompano, California	65					370
Rockfishes	1,570	195	7,780	2,085	6,486	46,723
Sculpin						312
Sea basses or "rock bass"	10	565		400	2,164	8,154
Sea bass, black	697	260	4,288	6,875	2,325	40,235
Sea bass, white or squeteague	103,032	68,773	58,103	142,918	4,175	500,075
"Smelt"	517	497	3,644	430	3,230	9,335
Tuna	5,966	3,850	10,410	195	136,548	267,156
Whitefish					200	800
Yellowtail	9,815	20,112	20,668	46,580	144,457	351,170
Other fish				150	2,117	2,467
Shrimps				30		30
Sea crawfish or spiny lobster			45,465	118,759	77,588	943,547
Abalones						8,094
Turtles				440		2,275
Total	449,420	301,063	649,521	1,069,317	760,254	6,699,817

FISHERIES OF MARYLAND AND VIRGINIA IN 1920.

The fisheries statistics contained in this report are based on a regular canvass of the fisheries of the States of Maryland and Virginia for the calendar year 1920.[7] The statistics of the oyster industry, however, represent the oyster season of 1920–21. This report also includes the number, quantity, and value of the catch of shad and alewives in the fishing season of 1921 for the two States. The statistics of the shad and alewife fishery of the Potomac River, following the practice of making an annual canvass of this fishery beginning with 1919, and brief history of the shad fishery of the Potomac River are given on pages 66 to 70.

[7] This canvass was made by Winthrop A. Roberts, Rob Leon Greer, Andrew J. Messner, and Fred F. Johnson.

EARLIER PUBLICATIONS.

Some of the earlier publications relating to the fisheries of Maryland and Virginia and published in Washington, D. C., follow:

1887. Maryland and Its Fisheries. By R. Edward Earll. *In* The Fisheries and Fishery Industries of the United States, by G. Brown Goode et al., Sec. II, Pt. X, p. 421–448.

Virginia and Its Fisheries. By Marshall McDonald. *Ibid.*, Sec. II, Pt. XI, p. 449–473.

History and Methods of the Fisheries. *Ibid.*, Sec. V, Vol. I (xi+808 p.) and Vol. II (xx+881 p. and atlas of 275 pls.).

1892. IV. Fisheries of the Middle Atlantic States [1887 and 1888]. *In* Statistical Review of the Coast Fisheries of the United States, prepared under the direction of J. W. Collins. Report, U. S. Commission of Fish and Fisheries, 1888 (1892), p. 323–351.

1894. The Oyster Industry of Maryland. By Charles H. Stevenson. Bulletin, U. S. Fish Commission, Vol. XII, 1892 (1894), p. 203–297.

1895. A Statistical Report on the Fisheries of the Middle Atlantic States. By Hugh M. Smith. Bulletin, U. S. Fish Commission, Vol. XIV, 1894 (1895), p. 339–467.

1899. The Shad Fisheries of the Atlantic Coast of the United States. By Charles H. Stevenson. Appendix, Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1898 (1899), p. 101–269.

Notes on the Extent and Condition of the Alewife Fisheries of the United States in 1896. By Hugh M. Smith. *Ibid.*, p. 31–43.

1901. Statistics of the Fisheries of the Middle Atlantic States [1897]. By C. H. Townsend. Appendix, Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1900 (1901), p. 195–310.

1904. Statistics of the Fisheries of the Middle Atlantic States [1901]. By Barton W. Evermann. Appendix, Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1902 (1904), p. 433–540.

1905. The Crab Industry of Maryland. By Winthrop A. Roberts. *In* Report of the Commissioner, U. S. Bureau of Fisheries, for 1904 (1905), p. 415–432.

1907. Statistics of the Fisheries of the Middle Atlantic States for 1904. *In* Report of the U. S. Commissioner of Fisheries for 1905 (1907), 122 p.

1911. Fisheries of the United States, 1908. Special Reports, Bureau of the Census.

1911. Shad and Alewife Fisheries [1909]. *In* Report of the U. S. Commissioner of Fisheries for 1910 (1911), p. 27–28.

1914. Oyster Industry [1912]. *In* Report of the U. S. Commissioner of Fisheries for 1913 (1914), p. 40–49.

1915. The Menhaden Industry of the Atlantic Coast. By Rob Leon Greer. Appendix III, Report of the U. S. Commissioner of Fisheries for 1914 (1915), 27 p., 7 pl.

1917. Crab Industry of Maryland and Virginia [1915]. *In* Report of the U. S. Commissioner of Fisheries for 1916 (1917), p. 60–64.

Shad and Alewife Industry of Chesapeake Bay and Tributaries [1915]. *Ibid.*, p. 65–72.

1919. Crab Industry of Chesapeake Bay. By E. P. Churchill, jr. Appendix IV, Report of the U. S. Commissioner of Fisheries for 1918 (1920), 25 p., XII pls.

1920. The Oyster and the Oyster Industry of the Atlantic and Gulf Coasts. By E. P. Churchill, jr. Appendix VIII, Report of the U. S. Commissioner of Fisheries for 1919 (1921), 51 p., XXIX pls., 5 figs.

COMMON AND SCIENTIFIC NAMES OF FISHES.

Following is a list of the common and scientific names of the fishes of Maryland and Virginia to which reference is made in this report:

Alewives	*Pomolobus æstivalis.* *Pomolobus pseudoharengus.*
Black Bass	*Micropterus salmoides.* *Micropterus dolomieu.*
Black drum	*Pogonias cromis.*
Bluefish	*Pomatomus saltatrix.*
Bonito	*Sarda sarda.*

Butterfish	*Poronotus triacanthus.*
Carp	*Cyprinus carpio.*
Catfish	Siluridæ (species).
Crevallé (including blue runner)	Caranx (species).
Croaker	*Micropogon undulatus.*
Eels	*Anguilla rostrata.*
Flounders	*Paralichthys dentatus.* Pleuronectidæ (species).
Gizzard shad	*Dorosoma cepedianum.*
Goldfish	*Carassius auratus.*
Hickory shad	*Pomolobus mediocris.*
King whiting	Menticirrhus (species).
Mackerel	*Scomber scombrus.*
Menhaden	*Brevoortia tyrannus.*
Mullet	*Mugil cephalus.* *Mugil curema.*
Ocean sunfish	*Mola mola.*
Perch, white	*Morone americana.*
Perch, yellow	*Perca flavescens.*
Pigfish	*Orthopristis chrysopterus.*
Pike or pickerel	Esox (species).
Pompano	Trachinotus (species).
Redfish or red drum	*Sciaenops ocellatus.*
Scup	*Stenotomus chrysops.*
Sea bass	*Centropristes striatus.*
Shad	*Alosa sapidissima.*
Sheepshead	*Archosargus probatocephalus.*
Spanish mackerel	*Scomberomorus maculatus.*
Spot	*Leiostomus xanthurus.*
Squeteagues or "sea trout"	*Cynoscion regalis.* *Cynoscion nebulosus.*
Striped bass	*Roccus lineatus.*
Sturgeon	*Acipenser sturio.*
Suckers	Castostomidæ (species).
Sunfish	Centrarchidæ (species).
Whiting	*Merluccius bilinearis.*
Yellowtail or "silver perch"	*Bairdiella chrysura.*

GENERAL STATISTICS.

The number of persons engaged in the fisheries, the investment, and the quantity and value of the products of the fisheries of Maryland and Virginia in 1920 are shown in the table which follows.

In 1920 the total number of persons engaged in these States was 40,761 as compared with 59,205 in 1904, a decrease of 18,444, or 31.15 per cent. The total investment was $18,275,933 as compared with $10,598,399 in 1904, an increase of $7,677,534, or 72.44 per cent. The products of the fisheries amounted to 530,749,884 pounds as compared with 426,311,000 pounds in 1908, an increase of 104,438,884 pounds, or 24.49 per cent, and 436,444,664 pounds in 1904, an increase of 94,305,220 pounds, or 21.60 per cent. The value of the products in 1920 was $12,740,392 as compared with $8,022,000 in 1908, an increase of $4,718,392, or 58.81 per cent, and $8,380,845 in 1904, an increase of $4,359,547, or 52.01 per cent.

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FISHERIES OF MARYLAND AND VIRGINIA, 1920.

Items.	Maryland.		Virginia.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	1,947		1,995	
On vessels transporting	733		563	
In shore fisheries	9,859		11,612	
Shoresmen	8,844		5,208	
Total	21,383		19,378	
INVESTMENT.				
Vessels, fishing, steam			45	$2,232,025
Tonnage			4,718	
Outfit				486,561
Vessels, fishing, gasoline	14	$11,050	81	456,975
Tonnage	197		1,150	
Outfit		2,860		108,523
Vessels, fishing, sail	402	451,385	44	29,350
Tonnage	4,133		354	
Outfit		95,817		14,572
Vessels, transporting, gasoline	124	231,200	222	375,450
Tonnage	1,479		2,125	
Outfit		44,562		80,752
Vessels, transporting, sail	184	352,275	56	128,900
Tonnage	5,131		1,536	
Outfit		41,348		13,660
Boats, sail, row, etc	3,264	197,508	5,476	194,136
Boats, power	3,128	958,598	3,404	994,000
Apparatus, vessel fisheries:				
Purse seines	3	900	50	121,800
Haul seines			1	150
Crab scrapes	91	636	24	172
Crab dredges			62	2,450
Oyster dredges	856	19,728	201	4,470
Tongs	28	382	22	276
Apparatus, shore fisheries:				
Purse seines	1	200		
Haul seines	218	24,836	196	41,505
Gill nets	4,247	86,176	15,152	98,108
Pound nets and weirs	1,072	390,285	1,882	895,762
Trammel nets	5	533		
Fyke nets	3,868	29,827	1,301	24,092
Bow nets	37	346		
Dip nets	1,305	1,389	867	560
Stop nets	2	125	4	120
Otter trawls	1	95	1	125
Lines, hand and trot		9,399		8,847
Slat traps or baskets	1	100	40	600
Eel pots	4,226	4,128	562	1,132
Eel spears	9	21	2	10
Crab traps			13	18
Crab scrapes	1,396	9,774	531	3,784
Crab dredges			56	1,056
Oyster dredges	547	13,067	217	3,610
Scallop dredges			304	2,244
Tongs, nippers, rakes, and hoes	6,006	44,628	5,421	45,000
Shore and accessory property		3,589,956		3,561,449
Cash capital		953,300		777,255
Total		7,566,434		10,709,499
PRODUCTS.	Pounds	Value	Pounds	Value
Alewives, fresh	5,647,388	114,470	16,635,100	258,358
Alewives, salted	1,426,300	62,770	30,000	900
Black bass	77,388	18,969	342,500	44,525
Black drum	700	8	59,980	792
Bluefish	73,595	16,764	178,475	27,211
Bonito	46,420	2,785	183,535	13,358
Butterfish	875,827	24,302	3,018,842	136,894
Carp	329,450	22,925	282,695	20,559
Catfish	471,207	29,367	826,485	48,383
Crevalle	3,200	96	760,448	24,378
Croaker	2,519,770	66,576	16,372,134	513,975
Eels, fresh	170,118	18,936	121,800	12,559
Eels, salted	31,450	3,145		
Flounders	287,765	15,078	313,584	15,715
Gizzard shad	30,067	913	[redacted]	[redacted]
Goldfish	500	38	4,050	380
Hickory shad	2,100	95	[redacted]	[redacted]
King whiting	9,190	1,741	40,222	3,411
Mackerel			70,677	8,473
Menhaden	7,500	30	366,379,425	2,158,518

86,785 2,620
216,520 8,150

FISHERIES OF MARYLAND AND VIRGINIA, 1920—Continued.

Items.	Maryland.		Virginia.	
PRODUCTS—continued.	Pounds ~~Number.~~	*Value.*	Pounds ~~Number.~~	*Value.*
Mullet	101,357	$5,162	458,158	$17,417
Ocean sunfish			100	20
Perch, white	321,739	32,991	648,165	46,638
Perch, yellow	310,398	31,452	117,755	10,547
Pigfish			69,300	3,523
Pike or pickerel	64,458	13,688	80,860	8,081
Pompano	734	147	6,930	1,430
Redfish or red drum	41,535	627	117,550	3,753
Scup	101,980	2,611	35,140	2,418
Sea bass	42,980	3,447	18,975	1,427
Shad	1,867,196	355,217	7,293,805	1,145,106
Sheepshead	51	8	2,155	263
Spanish mackerel	8,477	1,282	33,839	5,039
Spot	364,759	6,829	967,296	67,270
Squeteagues or "sea trout":				
Fresh	2,274,490	91,514	12,908,502	654,521
Salted	7,000	770		
Striped bass	1,040,274	193,295	379,568	68,858
Sturgeon	21,411	5,551	78,388	14,368
Sturgeon caviar	2,784	8,750	5,172	16,038
Sturgeon roe			101	150
Suckers	2,000	160	2,800	85
Sunfish	5,300	70		
Whiting	11,730	234		
Yellowtail or "silver perch"	400	40	3,350	126
Crabs, hard	[1] 5,165,703	248,160	[2] 12,465,342	401,295
Crabs, soft	[3] 3,897,271	494,784	[4] 1,171,737	164,269
Squid	468	29	42,150	1,475
Clams, hard	[5] 30,200	10,575	[6] 499,440	229,645
Oysters, market, public	[7] 29,953,581	2,111,345	[8] 10,757,488	993,548
Oysters, market, private	[9] 1,878,716	179,775	[10] 11,823,420	1,174,375
Oysters, seed, public			[11] 5,008,150	178,038
Oysters, seed, private			[12] 155,925	3,200
Scallops			[13] 113,760	26,852
Terrapin	823	1,000	248	360
Turtles	3,045	147	18,680	1,165
Frogs			480	120
Cabomba			900	90
Alewife scales			10,203	1,055
Total	59,530,795	4,198,668	471,219,089	8,541,724

[1] 15,497,109 in number.
[2] 37,396,026 in number.
[3] 11,691,813 in number.
[4] 3,515,211 in number.
[5] 3,775 bushels.
[6] 62,430 bushels.
[7] 4,279,083 bushels.
[8] 1,536,784 bushels.
[9] 268,388 bushels.
[10] 1,689,060 bushels.
[11] 715,450 bushels.
[12] 22,275 bushels.
[13] 18,960 bushels.

CRAB FISHERY OF MARYLAND AND VIRGINIA.

The decline of the crab fishery of Maryland and Virginia in recent years has been so rapid as to alarm those interested in its perpetuation, also to develop considerable interest as to the relative destructiveness of the various forms of apparatus of capture and the regulatory measures necessary to restore the fishery to its former magnitude.

At a conference at the Department of Commerce in Washington, D. C., on July 13, 1921, attended by the Commissioner of Fisheries of Virginia, the chairman of the Conservation Commission of Maryland, the Secretary and Assistant Secretary of Commerce, representatives of the Bureau of Fisheries, and others, the State authorities agreed to seek concurrent legislation upon the following: (1) That it be unlawful to take or have in possession a "sponge" bearing crab at any time of the year; (2) that it be unlawful to take crabs by the use of a trot line between December 1 and March 31, inclusive, and that the dredging of crabs be allowed only from December 1 to March 31, inclusive; (3) that the minimum size for a peeler crab be established at 3 inches from tip to tip of spine and for a soft crab at 3½ inches.

The crab product of Maryland and Virginia in 1920, by counties and for various years from 1880 to 1920, are shown in the tables which follow, and the quantities of hard and soft crabs, by States in various years, are shown in graphic form in Figure 7. The total catch in these States in 1920 was 22,700,053 pounds as compared

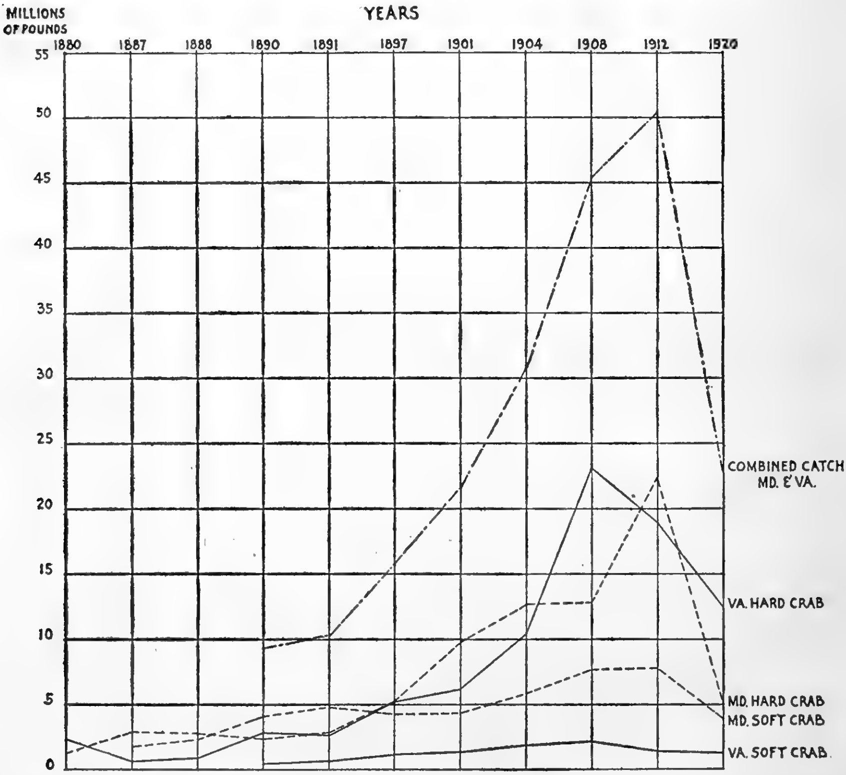

FIG. 7.—Crab product of Maryland and Virginia in millions of pounds, for various years, 1880 to 1920.

with 50,343,268 pounds in 1915, a decrease of 27,643,215 pounds, or 54.90 per cent. The decrease in Maryland in 1920 as compared with 1915 was 21,030,908 pounds, or 69.88 per cent, and in Virginia, 6,612,307 pounds, or 32.65 per cent.

HARD AND SOFT CRAB INDUSTRY OF MARYLAND AND VIRGINIA IN 1920, BY COUNTIES.

States and counties.	Crabs, hard.		Crabs, soft.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Maryland:						
Anne Arundel	761,195	$31,070	100,812	$28,160	862,007	$59,230
Baltimore	77,730	4,105	7,270	3,225	85,000	7,330
Calvert	73,125	2,800	32,058	7,095	105,183	9,895
Charles	137,575	4,815			137,575	4,815
Dorchester	1,140,182	70,988	215,791	26,403	1,355,973	97,391
Harford	6,000	300			6,000	300
Kent	440,000	19,225			440,000	19,225
Queen Annes	143,125	4,660			143,125	4,660
St. Marys	217,000	7,280	105,425	18,495	322,425	25,775
Somerset	764,229	55,764	3,435,915	411,406	4,200,144	467,170
Talbot	1,273,375	42,823			1,273,375	42,823
Wicomico	36,167	2,170			36,167	2,170
Worcester	96,000	2,160			96,000	2,160
Total	5,165,703	248,160	3,897,271	494,784	9,062,974	742,944
Virginia:						
Accomac	776,475	32,616	944,807	120,688	1,721,282	153,304
Elizabeth City	2,038,900	67,759			2,038,900	67,759
Gloucester	962,666	25,980			962,666	25,980
Isle of Wight	6,250	200			6,250	200
King George	64,375	2,060			64,375	2,060
King and Queen	56,250	1,350			56,250	1,350
King William	18,750	450			18,750	450
Lancaster	211,900	6,357	45,760	8,081	257,660	14,438
Mathews	926,200	28,138			926,200	28,138
Middlesex	622,700	18,681			622,700	18,681
Nansemond	200	75			200	75
Norfolk	1,206,075	41,951			1,206,075	41,951
Northampton	664,151	22,120	19,862	3,125	684,013	25,245
Northumberland	545,065	20,068	144,748	30,625	689,813	50,693
Princess Anne	900,000	21,600			900,000	21,600
Stafford	18,335	1,600			18,335	1,600
Westmoreland	255,000	7,655	560	150	255,560	7,805
York	3,192,050	102,635	16,000	1,600	3,208,050	104,235
Total	12,465,342	401,295	1,171,737	164,269	13,637,079	565,564
Grand total	17,631,045	649,455	5,069,008	659,053	22,700,053	1,308,508

COMPARATIVE STATISTICS OF THE CRAB PRODUCT OF MARYLAND AND VIRGINIA, VARIOUS YEARS, 1880 TO 1920.

Years.	Maryland.					
	Crabs, hard.		Crabs, soft.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
1880	1,166,667	$46,850	(1)	(1)		
1887	2,757,638	36,969	1,636,530	$133,788	4,394,168	$170,757
1888	2,674,675	37,438	2,208,829	161,331	4,883,504	198,769
1890	2,388,099	31,723	4,056,110	228,690	6,444,209	260,413
1891	2,776,898	37,460	4,828,872	266,256	7,605,770	303,716
1897	5,333,316	39,949	4,115,879	177,637	9,449,195	217,586
1901	9,824,793	85,884	4,303,582	202,563	14,128,375	288,447
1904	12,665,282	168,996	5,732,865	189,851	18,398,147	358,847
1908	12,786,000	124,000	7,587,000	195,000	20,373,000	319,000
1915	22,491,675	335,375	7,602,207	329,276	30,093,882	664,651
1920	5,165,703	248,160	3,897,271	494,784	9,062,974	742,944

Years.	Virginia.						Grand total.	
	Crabs, hard.		Crabs, soft.		Total.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
1880	2,139,200	$32,088	(1)	(1)				
1887	626,820	15,479	(1)	(1)				
1888	956,843	24,669	(1)	(1)				
1890	2,584,794	28,210	440,310	$26,054	3,025,104	$54,264	9,469,313	$314,677
1891	2,208,071	32,683	585,956	29,379	2,794,027	62,062	10,399,797	365,778
1897	5,331,398	28,331	1,068,116	39,914	6,399,514	68,245	15,848,709	285,831
1901	6,113,277	52,863	1,288,424	65,972	7,401,701	118,835	21,530,076	407,282
1904	10,356,052	179,575	1,910,654	92,909	12,266,706	272,484	30,664,853	631,331
1908	23,001,000	239,000	2,082,000	87,000	25,083,000	326,000	45,456,000	645,000
1915	18,765,148	242,754	1,484,238	74,402	20,249,386	317,156	50,343,268	981,807
1920	12,465,342	401,295	1,171,737	164,269	13,637,079	565,564	22,700,053	1,308,508

1 Statistics not available.

SHAD AND ALEWIFE FISHERIES OF MARYLAND AND VIRGINIA.

The perpetuation of these important fisheries is a subject of special concern to the States of Maryland and Virginia. As the fisheries are conducted at the same seasons with the same apparatus and present like problems, association of statistical tables and discussions regarding them is a matter of convenience. In making the canvass it was found practicable to obtain statistics of the catch for 1921 in addition to the detailed statistics for 1920.

In 1920 the catch of shad in Maryland was 1,867,196 pounds, valued at $355,217, and in Virginia 7,293,805 pounds, valued at $1,145,106, a total of 9,161,001 pounds, valued at $1,500,323. In 1921 the catch in Maryland was 1,807,074 pounds, valued at $347,396, and in Virginia 6,936,001 pounds, valued at $1,204,595, a total of 8,743,075 pounds, valued at $1,551,991.

Compared with 1915 there was an increase of 412,661 pounds, or 28.37 per cent, in the catch of shad in Maryland in 1920 and of 352,539 pounds, or 24.23 per cent, in 1921. The increase in Virginia in 1920 as compared with 1915 was 2,579,671 pounds, or 54.72 per cent, and in 1921, 2,221,867 pounds, or 47.13 per cent.

The catch of alewives in 1920 in Maryland amounted to 7,071,688 pounds, valued at $177,190, and in Virginia to 16,665,100 pounds, valued at $259,258, a total of 23,736,788 pounds, valued at $436,448. In 1921 the catch in Maryland amounted to 6,504,845 pounds, valued at $144,584, and in Virginia to 18,834,164 pounds, valued at $245,945, a total of 25,339,009 pounds, valued at $390,529.

In 1920 there was a decrease in the catch of alewives in Maryland amounting to 5,495,892 pounds, or 43.73 per cent, as compared with 1915. There was a further decrease in 1921 amounting to 6,062,735 pounds, or 48.24 per cent, as compared with 1915. In comparison with 1915 the catch of alewives in Virginia shows an increase in 1920 and 1921, amounting to 610,970 pounds, or 3.80 per cent, in 1920, and 2,780,034 pounds, or 17.31 per cent, in 1921.

Comparative statistics of these fisheries for various years, the catch in Chesapeake Bay and its tributaries, and the number and value of shad, by counties, are shown in the tables which follow. The catch of the Potomac River is shown in detail on pages 66 to 67

COMPARATIVE STATISTICS OF THE SHAD AND ALEWIFE PRODUCT OF MARYLAND AND VIRGINIA, VARIOUS YEARS, 1880 TO 1921.[1]

Years.	Maryland.					Virginia.	
	Shad.		Alewives.		Total.	Shad.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Value.*	*Pounds.*	*Value.*
1880	3,774,426	$140,926	9,203,959	$139,667	$280,593	3,171,953	$134,496
1887	4,010,820	146,951	11,062,270	89,273	236,234	3,815,126	172,272
1888	4,868,435	176,655	11,511,774	110,291	286,946	7,056,473	321,634
1890	7,127,486	242,909	19,766,994	143,793	386,702	7,266,207	228,897
1891	6,224,873	211,575	17,418,850	131,245	342,820	6,498,242	207,394
1896	5,541,499	166,551	17,667,315	126,050	292,601	11,170,519	307,055
1897	5,799,563	159,365	17,139,459	123,453	282,818	11,529,474	304,448
1901	3,111,181	120,602	13,747,157	91,308	211,910	6,972,212	366,203
1904	2,912,249	159,772	14,484,970	137,982	297,754	7,419,899	439,625
1908	3,937,000	247,000	28,805,000	157,000	404,000	7,314,000	486,000
1909	3,252,688	272,869	23,637,320	155,499	428,368	6,030,200	488,336
1915	1,454,535	191,517	12,567,580	131,779	323,296	4,714,134	658,010
1920	1,867,196	355,217	7,071,688	177,190	532,407	7,293,805	1,145,106
1921	1,807,074	347,396	6,504,845	144,584	491,980	6,936,001	1,204,595

[1] The catch of shad and alewives in these States outside of the Chesapeake Bay region is included for some years, but is practically negligible.

COMPARATIVE STATISTICS OF THE SHAD AND ALEWIFE PRODUCT OF MARYLAND AND VIRGINIA, VARIOUS YEARS, 1880 TO 1921—Continued.

Years.	Virginia.			Grand total.			
	Alewives.		Total.	Shad.		Alewives.	
	Pounds.	*Value.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
1880	6,925,413	$76,300	$210,796	6,946,379	$275,422	16,129,372	$215,967
1887	4,401,635	29,585	201,857	7,855,946	319,223	15,463,905	118,858
1888	6,453,005	40,369	362,003	11,924,908	498,289	17,964,779	150,660
1890	10,641,698	91,674	320,571	14,393,693	471,806	30,408,692	235,467
1891	11,013,485	93,905	301,299	12,723,115	418,969	28,432,335	225,150
1896	12,197,607	63,024	370,079	16,712,018	473,606	29,864,922	189,074
1897	13,689,510	70,841	375,289	17,329,037	463,813	30,828,969	194,294
1901	13,913,444	115,424	481,627	10,083,393	486,805	27,660,601	206,732
1904	14,603,866	90,733	530,358	10,332,148	599,397	29,088,836	228,715
1908	37,885,000	171,000	657,000	11,251,000	733,000	66,690,000	328,000
1909	27,787,980	128,375	616,711	9,282,888	761,205	51,425,300	283,874
1915	16,054,130	165,950	823,960	6,168,669	849,527	28,621,710	297,729
1920	16,665,100	259,258	1,404,364	9,161,001	1,500,323	23,736,788	436,448
1921	18,834,164	245,945	1,445,539	8,743,075	1,551,991	25,339,009	390,529

CATCH OF SHAD AND ALEWIVES IN CHESAPEAKE BAY AND ITS SEVERAL TRIBUTARIES IN 1920 AND 1921.

Waters.	Shad.				Alewives.			
	1920		1921		1920		1921	
Chesapeake Bay:	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Virginia	1,056,736	$509,935	1,066,227	$623,969	17,401,503	$98,019	17,384,450	$87,275
Maryland	370,099	202,078	405,789	239,223	11,456,400	98,223	10,521,345	79,055
Total	1,426,835	712,013	1,472,016	863,192	28,857,903	196,242	27,905,795	166,330
James River and tributaries	326,720	210,684	276,808	168,325	4,791,563	43,139	3,986,500	34,615
York River and tributaries	75,839	49,734	74,581	48,755	5,000	50	5,000	50
Rappahannock River	71,133	29,564	71,428	43,002	1,954,230	17,943	2,377,450	18,666
Potomac River:								
Virginia	448,414	278,501	356,191	182,179	7,681,561	41,197	8,908,510	35,031
Maryland	80,944	55,963	49,681	25,191	1,077,775	13,940	1,395,000	9,010
Total	529,358	334,464	405,872	207,370	8,759,336	55,137	10,303,510	44,041
Patuxent River	8,292	6,955	3,661	2,777	48,100	534	69,975	1,022
Middle River	....	....	....	....	6,143	76	7,788	44
Gunpowder River	....	....	....	....	12,288	151	15,575	91
Bird River	....	....	....	....	18,431	226	23,362	136
Bush River	205	98	600	350	205,000	1,735	135,000	925
Susquehanna River (Md.)[1]	15,020	7,338	10,775	6,520	2,105,700	31,146	1,908,770	28,155
Elk River	2,150	1,002	1,300	780	542,700	5,564	509,700	5,097
Bohemia River	....	....	....	....	92,500	1,053	57,500	575
Chester River	150	72	750	370	124,300	893	214,500	2,442
Choptank River	46,304	19,205	47,834	19,637	324,837	1,965	303,150	1,561
Tuckahoe Creek	980	644	811	532	3,000	16	3,375	18
Little Choptank River	3,849	2,266	4,700	2,716	66,955	217	49,200	158
Fishing Bay	18,882	8,502	19,507	8,788	113,950	680	100,738	526
Blackwater River	7,224	4,200	4,330	2,375	138,800	967	239,400	1,434
Transquaking River	2,066	1,171	2,328	1,301	72,875	576	104,375	794
Chicamicomico River	47	31	39	27	22,375	90	20,000	80
Nanticoke River (Md.)[2]	16,675	11,111	17,080	11,395	196,550	1,719	191,125	1,392
Wicomico River	12,351	9,775	12,676	9,666	157,087	1,035	145,837	941
Manokin River	956	432	991	449	....	....	....	....
Pocomoke River (Md.)[3]	17,131	9,188	15,474	7,920	156,692	2,109	138,340	1,519
Tangier Sound:								
Virginia	27,570	13,722	22,412	11,205	257,328	1,930	233,280	1,862
Maryland	4,000	2,141	3,685	1,936	198,535	1,520	216,833	1,662
Total	31,570	15,863	26,097	13,141	455,863	3,450	450,113	3,524

[1] There was no commercial fishing in the Susquehanna River in Pennsylvania in 1920 and 1921.
[2] No canvass of the fisheries of Nanticoke River in Delaware was made for 1920 or 1921.
[3] There was no commercial fishing for shad and alewives in the Pocomoke River in Virginia in 1920 and 1921.

CATCH OF SHAD AND ALEWIVES IN CHESAPEAKE BAY AND ITS SEVERAL TRIBUTARIES IN 1920 AND 1921—Continued.

Waters.	Shad.				Alewives.			
	1920		1921		1920		1921	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Pocomoke Sound:								
Virginia	57,339	$30,166	45,450	$23,637	496,853	$3,825	436,520	$3,476
Maryland	1,447	963	1,456	955	19,538	117	18,175	109
Total	58,786	31,129	46,906	24,592	516,391	3,942	454,895	3,585
Grand total	2,672,523	1,465,441	2,516,564	1,443,980	[4] 49,748,569	370,655	[5] 49,720,973	317,721

[4] Includes 4,504,750 alewives salted by the fishermen, valued at $63,670.
[5] Includes 4,597,450 alewives salted by the fishermen, valued at $59,951.

NUMBER AND VALUE OF SHAD TAKEN IN EACH COUNTY OF MARYLAND AND VIRGINIA IN 1920 AND 1921.

Counties.	1920		1921	
	Number.	*Value.*	*Number.*	*Value.*
Maryland:				
Anne Arundel	11,895	$8,642	18,335	$9,755
Baltimore	40	30	150	105
Calvert	26,623	13,576	38,435	14,085
Caroline	5,710	3,714	5,901	3,828
Cecil	60,024	28,097	54,153	32,717
Charles	57,725	39,227	38,938	18,930
Dorchester	103,955	60,220	84,694	44,541
Harford	22,847	10,606	21,060	12,476
Kent	109,410	59,319	121,100	77,977
Prince Georges	26,329	19,435	6,773	3,877
Queen Annes	430	299	1,250	780
St. Marys	28,450	14,141	22,990	13,808
Somerset	12,845	6,939	12,643	6,791
Talbot	98,271	60,452	128,380	79,195
Wicomico	26,876	19,413	27,763	19,558
Worcester	18,029	11,107	16,072	8,973
Total	[1] 609,459	355,217	[2] 598,637	347,396
Virginia:				
Accomac	150,649	77,172	99,560	51,466
Arlington	26,740	15,288	37,158	22,895
Caroline	2,195	989	710	406
Charles City	79,000	56,770	63,000	40,458
Chesterfield [3]	10,000	6,900	7,250	5,001
Elizabeth City	113,500	54,210	139,000	83,300
Dinwiddie	4,000	2,760	2,100	1,452
Essex	2,950	1,328	595	357
Fairfax	31,209	19,150	26,030	13,433
Gloucester	67,073	31,568	52,208	32,071
Isle of Wight	57,445	41,325	40,619	29,128
James City	36,750	22,208	33,460	18,449
King George	18,970	10,886	11,418	6,884
King and Queen	49,807	32,941	43,850	28,371
King William	11,992	7,466	14,051	9,244
Lancaster	171,553	82,019	173,884	99,443
Mathews	637,425	305,916	653,245	392,256
Middlesex	6,444	2,900	8,833	4,625
Nansemond	19,975	14,275	10,395	7,444
New Kent	63,890	32,322	72,480	36,806
Norfolk	19,395	6,747	37,879	25,553
Northampton	3,957	2,258	2,098	1,390
Northumberland	452,659	218,070	414,729	206,626
Princess Anne	7,691	5,025	6,944	3,800
Prince George	26,000	18,480	20,000	13,800
Prince William	26,890	17,176	16,870	9,201
Richmond	15,119	7,009	14,165	8,499
Spotsylvania	3,345	2,075	2,806	1,375
Stafford	13,065	7,163	7,175	4,105
Surry	13,050	8,127	12,915	7,619
Warwick	21,450	11,936	19,270	12,218
Westmoreland	8,335	4,767	11,733	5,520
York	37,250	17,880	38,300	21,400
Total	[4] 2,209,773	1,145,106	[5] 2,094,730	1,204,595

[1] 1,867,196 pounds. [2] 1,807,074 pounds.
[3] The shad catch for Chesterfield County in 1921 was inadvertently omitted from Statistical Bulletin No. 520 for Maryland and Virginia. The correct catch for Virginia on the bulletin should be 6,936,001 pounds, valued at $1,204,595.
[4] 7,293,805 pounds. [5] 6,936,001 pounds.

OYSTER INDUSTRY OF MARYLAND AND VIRGINIA.

The total quantity of oysters taken in Maryland and Virginia in 1920 was 8,511,040 bushels, valued at $4,640,081, of which 4,547,471 bushels, valued at $2,291,120, are credited to Maryland and 3,963,569 bushels, valued at $2,348,961, to Virginia. The decline in this important fishery in recent years has been quite marked. In comparison with 1912 there was a decrease of 962,950 bushels, or 17.47 per cent, in Maryland and of 2,242,529 bushels, or 36.13 per cent, in Virginia, the decrease in the two States amounting to 3,205,479 bushels, or 27.35 per cent.

Following are statistics of the oyster industry of Maryland and Virginia for various years and for 1920, by counties, and a graph (Fig. 8) of the catch for various years in millions of bushels.

OYSTER INDUSTRY OF MARYLAND AND VIRGINIA, VARIOUS YEARS, 1880 TO 1920.

Years.	Maryland.			Virginia.			Total.		
	Bushels.	*Pounds.*	*Value.*	*Bushels.*	*Pounds.*	*Value.*	*Bushels.*	*Pounds.*	*Value.*
1880	10,600,000	74,200,000	$4,730,476	6,837,320	47,861,240	$2,218,376	17,437,320	122,061,240	$6,948,852
1887	8,148,217	57,037,519	2,683,435	[1]2,921,140	20,447,980	1,002,901	11,069,357	77,485,499	3,686,336
1888	8,531,658	59,721,606	2,877,790	3,664,433	25,651,031	1,336,012	12,196,091	85,372,637	4,213,802
1890	10,450,087	73,150,609	4,854,746	6,074,025	42,518,175	2,482,348	16,524,112	115,668,784	7,337,094
1891	9,945,058	69,615,406	5,295,866	6,162,086	43,134,602	2,524,348	16,107,144	112,750,008	7,820,214
1897	7,254,934	50,784,538	2,885,202	7,023,848	49,166,936	2,041,683	14,278,782	99,951,474	4,926,885
1901	5,685,561	39,798,927	3,031,518	6,067,669	42,473,683	2,621,915	11,753,230	82,272,610	5,653,433
1904	4,429,650	31,007,550	2,417,674	7,612,289	53,286,023	3,459,676	12,041,939	84,293,573	5,877,350
1908	6,232,000	43,624,000	2,228,000	5,075,000	35,525,000	2,348,000	11,307,000	79,149,000	4,576,000
1912	5,510,421	38,572,947	2,127,759	6,206,098	43,442,686	2,286,340	11,716,519	82,015,633	4,414,099
1920	4,547,471	31,832,297	2,291,120	3,963,569	27,744,983	2,348,961	8,511,040	59,577,280	4,640,081

[1] Exclusive of the James and Potomac Rivers.

THE OYSTER FISHERY OF MARYLAND AND VIRGINIA IN 1920, BY COUNTIES.

States and counties.	Market oysters from natural rock.		Market oysters from private beds.		Seed oysters from natural rock.		Seed oysters from private beds.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bush.*	*Value.*	*Bush.*	*Value.*	*Bushels.*	*Value.*
Maryland:										
Anne Arundel	293,500	$124,726	3,350	$1,990					296,850	$126,716
Baltimore	106,635	56,100							106,635	56,100
Calvert	136,530	101,570	15,075	12,250					151,605	113,820
Charles	57,625	30,265	14,700	7,625					72,325	37,890
Dorchester	1,183,951	563,528	22,700	14,755					1,206,651	578,283
Kent	136,220	40,866							136,220	40,866
Queen Annes	265,700	106,280							265,700	106,280
St. Marys	279,335	157,495	19,060	8,210					298,395	165,705
Somerset	702,462	526,179	37,732	28,156					740,194	554,335
Talbot	961,687	308,854	4,150	1,245					965,837	310,099
Wicomico	133,596	80,501	125,500	63,750					259,096	144,251
Worcester	21,842	14,981	26,121	41,794					47,963	56,775
Total	4,279,083	2,111,345	268,388	179,775					4,547,471	2,291,120
Virginia:										
Accomac	160,949	111,984	285,571	203,120	30,500	8,825	20,000	2,450	497,020	326,379
Elizabeth City	22,500	11,025	324,822	204,360	78,300	19,575			425,622	234,960
Essex	25,850	18,095	27,200	19,040					53,050	37,135
Gloucester	34,370	25,654	136,797	103,973	2,000	500			173,167	130,107
Isle of Wight	75,000	33,750	19,655	9,827	169,100	42,275			263,755	85,852
James City			54,000	40,500					54,000	40,500
King George	7,330	3,600							7,330	3,600
King and Queen	2,700	1,790	60,000	45,500					62,700	47,290
King William			77,000	58,707					77,000	58,707
Lancaster	156,405	131,612	47,034	38,878					203,439	170,490
Mathews	94,466	70,320	64,776	46,695					159,242	117,015
Middlesex	302,620	236,321	1,050	735					303,670	237,056
Nansemond	124,800	56,360	56,955	28,450	103,250	25,813			285,005	110,623
New Kent			1,300	1,000					1,300	1,000
Norfolk	105,000	57,750	151,083	95,911					256,083	153,661

THE OYSTER FISHERY OF MARYLAND AND VIRGINIA IN 1920, BY COUNTIES—Contd.

States and counties.	Market oysters from natural rock.		Market oysters from private beds.		Seed oysters from natural rock.		Seed oysters from private beds.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bush.*	*Value.*	*Bush.*	*Value.*	*Bushels.*	*Value.*
Virginia—Contd.										
Northampton...	30,650	$17,808	208,233	$123,076	40,500	$8,100	......	......	279,383	$148,984
Northumberland	80,996	55,850	58,930	46,540	......	......	......	......	139,926	102,390
Princess Anne..	....	....	12,451	35,772	......	......	2,275	$750	14,726	36,522
Richmond......	29,605	21,525	21,500	19,230	......	......	......	......	51,105	40,755
Warwick........	75,250	37,550	5,000	2,500	120,000	30,000	......	......	200,250	70,050
Westmoreland..	145,193	73,454	10,150	3,875	......	......	......	......	155,343	77,329
York...........	63,100	29,120	65,553	46,686	171,800	42,950	......	......	300,453	118,756
Total........	1,536,784	993,548	1,689,060	1,174,375	715,450	178,038	22,275	3,200	3,963,569	2,349,161
Grand total.	5,815,867	3,104,893	1,957,448	1,354,150	715,450	178,038	22,275	3,200	8,511,040	4,640,281

FISHERIES OF MARYLAND.

In 1920 the number of persons employed in the fisheries of Maryland was 21,383, of whom 1,947 were on vessels fishing, 733 on transporting vessels, 9,859 in the shore or boat fisheries, and 8,844 on shore in wholesale establishments, canneries, and other fishing industries.

The investment in fisheries amounted to $7,566,434 and includes 416 steam and gasoline fishing vessels, valued at $462,435, with a net tonnage of 4,330 tons and outfits valued at $98,677; sail and gasoline transporting vessels to the number of 308, valued at $583,475, with a net tonnage of 6,610 tons and outfits valued at $85,910; power, sail, row, and other boats to the value of $1,156,106; fishing apparatus employed on vessels to the value of $21,646; fishing apparatus employed in shore or boat fisheries to the value of $614,929; shore and accessory property to the value of $3,589,956; and cash capital amounting to $953,300.

Products of the fisheries amounted to 59,530,795 pounds, with a value of $4,198,668 to the fishermen. The species of chief importance arranged in the order of their value were: Oysters, 4,547,471 bushels, or 31,832,297 pounds, valued at $2,291,120; crabs to the number of 27,188,922, or 9,062,974 pounds, valued at $742,944; shad, 1,867,196 pounds, valued at $355,217; striped bass, 1,040,274 pounds, valued at $193,295; alewives, fresh and salted, 7,073,688 pounds, valued at $177,240; squeteagues or "sea trout," fresh and salted, 2,281,490 pounds, valued at $92,284; and croakers, 2,519,770 pounds, valued at $66,576.

Compared with 1904 there were decreases in the number of persons employed in the fisheries of Maryland of 8,954, or 29.51 per cent, and in the quantity of products taken, amounting to 21,598,071 pounds, or 26.62 per cent, but increases in the investment amounting to $1,582,969, or 26.45 per cent, and in the value of the product amounting to $862,108, or 25.83 per cent.

For comparative purposes the products of certain of the important fisheries of the State for various years are shown in the following table. It will be noted that there has been a marked decline in the catch of alewives, shad, crabs, and oysters. In 1890 these four products represented 74 per cent of the total catch of fishery products in the State; in 1891, 71.39 per cent; in 1897, 93.88 per cent; in 1901,

85.30 per cent; in 1904, 82.34 per cent; in 1908, 85.09 per cent; and in 1920, 83.71 per cent. These percentages clearly indicate the importance of these four fisheries to the State of Maryland and the

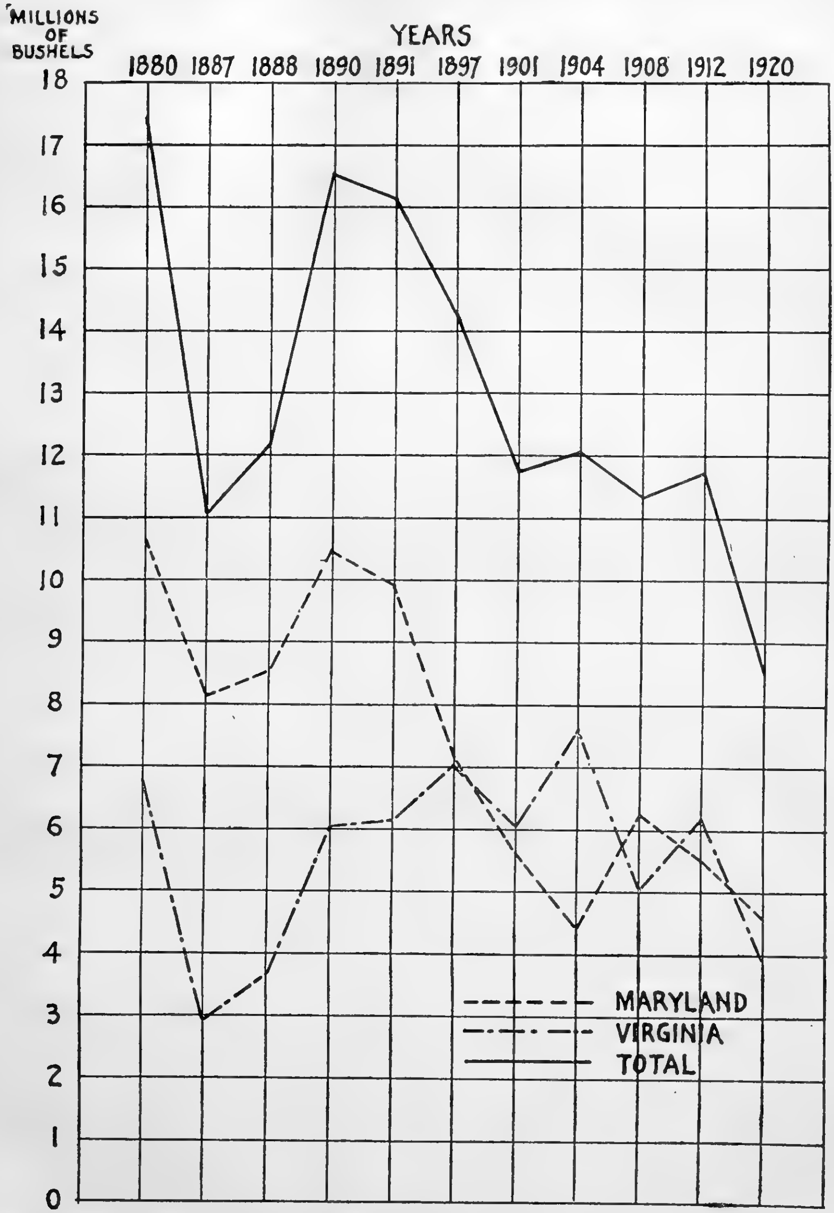

FIG. 8.—Catch of oysters in Maryland and Virginia in millions of bushels, for various years, 1880 to 1920.

importance of their perpetuation without danger of serious impairment if its fishing industry is to continue to be one of importance.

The catch of croakers and squetegues or "sea trout" shows a material increase. The catch of striped bass decreased from 1890 to 1908, but shows a substantial increase in 1920, being slightly less than the catches of 1890 and 1891.

PRODUCTS OF CERTAIN FISHERIES OF MARYLAND, VARIOUS YEARS, 1890 TO 1921.

Species.	1890	1891	1897	1901	1904	1908	1915	1920	1921
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Alewives	19,766,994	17,418,850	17,139,459	13,747,157	14,484,970	28,805,000	12,567,580	7,073,688	6,504,845
Croaker			236,295	303,405	165,840	179,000		2,519,770	
Shad	7,127,486	6,224,873	5,799,563	3,111,181	2,912,249	3,937,000	1,454,535	1,867,196	1,807,074
Squeteagues or "sea trout"	687,173	750,465	597,179	1,018,775	785,215	1,191,000		2,281,490	
Striped bass	1,365,928	1,264,693	935,347	824,418	721,240	640,000		1,040,274	
Crabs	6,444,209	7,605,770	9,449,195	14,128,375	18,398,147	20,373,000	30,093,882	9,062,974	
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	
Oysters	10,450,087	9,945,058	7,254,934	5,685,561	4,429,650	6,232,000	[1]5,510,421	4,547,471	

[1] For 1912.

FISHERIES BY COUNTIES.

The number of persons engaged, the investment, and products of the fisheries of Maryland in 1920 are shown, by counties, in the appended table. In the number of persons employed Somerset leads with 5,263, Dorchester ranking second with 3,820. The largest investment is in Baltimore City. Dorchester County leads in quantity of products but ranks second in the value of products, the value of the catch of Somerset County being greater.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES.

Items.	Anne Arundel.		Baltimore.[1]		Calvert.		Caroline.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	10		149		52			
On vessels transporting	52		87		35			
In shore fisheries	1,067		192		607		66	
Shoresmen	480		2,015		61			
Total	1,609		2,443		755		66	
INVESTMENT.								
Vessels fishing:								
Gasoline	4	$1,800			7	$3,350		
Tonnage	26				148			
Outfit		700				1,260		
Sail			24	$42,300	8	11,200		
Tonnage			711		113			
Outfit				16,175		2,600		
Vessels transporting:								
Gasoline	21	31,400	6	12,450	4	5,800		
Tonnage	247		111		54			
Outfit		6,085		3,100		1,200		
Sail	6	9,500	23	49,950	8	20,800		
Tonnage	110		1,076		343			
Outfit		1,200		6,930		2,835		
Boats:								
Sail, row, etc	307	7,990	116	2,690	218	7,085	36	$915
Power	422	115,725	29	5,975	194	54,210	6	1,075
Apparatus, vessel fisheries:								
Dredges			96	2,325	22	425		
Tongs	16	130			8	222		

[1] Includes Baltimore City.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES—Continued.

Items.	Anne Arundel.		Baltimore.		Calvert.		Caroline.	
INVESTMENT—contd.								
Apparatus, shore fisheries:	*Nnmber.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Haul seines	52	$1,631	29	$2,710	18	$1,620	5	$500
Gill nets	15	330	27	1,160	17	185	121	2,757
Trammel nets	1	125						
Pound nets	44	16,610	17	2,075	45	8,185	3	325
Fyke nets	124	305	338	3,315			51	955
Dip nets	101	44			77	26		
Stop nets	2	125						
Lines, hand and trot		1,176		246		60		
Eel pots	100	175	220	375				
Tongs and nippers	880	7,070			586	5,018		
Shore and accessory property		113,265		1,885,447		6,815		290
Cash capital		27,400		146,450		4,600		
Total		342,786		2,183,673		137,496		6,817
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	301,600	$5,457	15,745	$473	247,040	$4,525	19,870	$199
Alewives, salted					21,000	1,250		
Black bass	100	31	2,876	667				
Bluefish	90	10			50	10		
Butterfish					675	55		
Carp	36,500	2,893	8,262	761	6,510	405	750	39
Catfish	36,150	2,179	80,771	3,280	24,725	1,530	1,705	159
Croaker	84,175	3,447	5,000	200	279,400	6,155		
Eels, fresh	10,100	955	18,017	1,664	550	55		
Flounders	4,350	430			3,965	500		
Gizzard shad	5,175	110	6,225	118	3,100	160		
Hickory shad					600	25		
Mullet	2,000	240	1,160	99	950	110		
Perch, white	12,390	1,300	40,938	4,801	13,035	1,448	8,751	577
Perch, yellow	13,805	1,905	14,601	1,836	5,520	848	1,325	89
Pike or pickerel	4,030	899	5,405	1,184	1,825	405	35	6
Shad	35,892	8,642	110	30	74,680	13,576	17,427	3,714
Spanish mackerel					100	25		
Spot	2,925	170	450	45	5,010	481		
Squeteagues or "sea trout": Fresh	78,825	6,155	32,392	3,296	8,785	745		
Striped bass	47,240	7,353	65,085	10,617	12,758	3,025	2,470	470
Sunfish			200	1				
Crabs, hard	761,195	31,070	77,730	4,105	73,125	2,800		
Crabs, soft	100,812	28,160	7,270	3,225	32,058	7,095		
Oysters, market, public	2,054,500	124,726	746,445	56,100	955,710	101,570		
Oysters, market, private	23,450	1,990			105,525	12,250		
Total	3,615,304	228,122	1,128,682	92,502	1,876,696	159,048	52,333	5,253

Items.	Cecil.		Charles.		Dorchester.		Harford.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing			10		658			
On vessels transporting	11		6		161		3	
In shore fisheries	213		437		1,255		116	
Shoresmen	13		100		1,746		190	
Total	237		553		3,820		309	
INVESTMENT.								
Vessels fishing:								
Sail			2	$1,000	141	$129,110		
Tonnage			16		1,055			
Outfit				695		21,334		
Vessels transporting:								
Gasoline	3	$3,300	1	1,200	22	44,550	1	$2,000
Tonnage	20		30		319		7	
Outfit		1,200		700		4,765		400

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES—Continued.

Items.	Cecil.		Charles.		Dorchester.		Harford.	
INVESTMENT—contd.								
Vessels transporting—Continued.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Sail	1	$2,000	1	$600	48	$110,400		
Tonnage	9		17		1,559			
Outfit		350		375		7,553		
Boats:								
Sail, row, etc.	60	2,890	150	4,250	400	35,950	27	$1,800
Power	78	20,255	134	25,525	511	119,930	43	13,625
Apparatus, vessel fisheries:								
Scrapes					36	251		
Dredges			4	120	282	6,000		
Apparatus, shore fisheries:								
Haul seines	20	2,405	36	4,670	7	1,850	8	3,775
Gill nets	309	9,437	55	9,975	49	717	371	7,103
Trammel nets	3	208					1	200
Pound nets	122	23,950	59	8,150	227	44,470	14	6,200
Fyke nets	1,853	8,086	123	590	3	50	210	1,020
Dip nets	5	10			67	60	12	48
Lines, hand and trot				126		3,790		5
Slat traps or baskets							1	100
Eel pots	25	50	133	205	2,720	1,975	320	640
Crab scrapes					140	980		
Dredges			11	330	216	4,720		
Tongs and nippers			256	1,844	800	5,604		
Shore and accessory property		18,250		42,545		340,898		20,150
Cash capital		900		6,100		178,800		1,000
Total		93,291		109,000		1,063,757		58,066
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	692,880	$18,711	370,900	$12,320	595,482	$8,839	453,840	$10,599
Alewives, salted	477,900	12,088					230,400	24,480
Black bass	46,440	11,612	12,775	2,976	3,210	785	2,540	638
Black drum					700	8		
Bluefish					1,630	247		
Butterfish					1,915	137		
Carp	85,230	7,293	49,525	2,887	7,685	355	24,093	1,206
Catfish	44,406	3,707	82,700	3,717	44,680	2,423	9,610	898
Croaker			17,470	670	380,945	10,573		
Eels, fresh	9,785	989	6,345	780	71,323	8,519	4,800	435
Eels, salted					27,400	2,740		
Flounders					11,300	579		
Gizzard shad			2,750	64	4,917	140		
Goldfish			500	38				
Hickory shad	1,000	50						
Mullet	11,137	335	795	57	150	12	890	67
Perch, white	52,600	6,310	25,965	2,084	53,433	3,606	8,400	1,008
Perch, yellow	42,547	5,087	52,455	4,126	31,920	1,789	7,950	954
Pike or pickerel	19,670	4,082	11,695	2,301	4,613	921	4,015	1,004
Redfish or "red drum"					2,500	41		
Shad	165,762	28,097	190,024	39,227	348,883	60,220	63,964	10,606
Spot			360	25	8,500	420		
Squeteagues or "sea trout," fresh			5,000	345	28,610	2,230		
Striped bass	85,105	17,021	25,040	4,620	83,151	15,768	63,200	12,640
Sturgeon			45	15	150	30		
Suckers	1,000	80					1,000	80
Sunfish	3,900	39	200	20				
Yellowtail or "silver perch"					400	40		
Crabs, hard			137,575	4,815	1,140,182	70,988	6,000	300
Crabs, soft					215,791	26,403		
Oysters, market, public			403,375	30,265	8,287,657	563,528		
Oysters, market, private			102,900	7,625	158,900	14,755		
Turtles	350	18	1,000	45				
Total	1,739,712	115,519	1,499,394	119,022	11,516,027	796,096	880,702	64,915

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES—Continued.

Items.	Kent.		Prince Georges.		Queen Annes.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	14				2	
On vessels transporting	39				26	
In shore fisheries	424		66		592	
Shoresmen	28				221	
Total	505		66		841	
INVESTMENT.						
Vessels fishing:						
Gasoline					1	$1,500
Tonnage					5	
Outfit						100
Sail	2	$1,800				
Tonnage	43					
Outfit		300				
Vessels transporting:						
Gasoline	4	8,400			3	4,500
Tonnage	98				32	
Outfit		3,225				725
Sail	14	16,800			7	7,800
Tonnage	379				164	
Outfit		2,020				1,260
Boats:						
Sail, row, etc	71	3,325	44	$1,225	116	3,505
Power	212	58,085	5	1,325	253	59,400
Apparatus, vessel fisheries:						
Purse seines	2	400				
Tongs					2	15
Apparatus, shore fisheries:						
Purse seines	1	200				
Haul seines	9	1,625	3	160	17	2,160
Gill nets	2,212	27,285	34	4,525	3	90
Pound nets	67	25,550	12	650	18	1,500
Fyke nets	754	4,391	88	400	130	1,695
Lines, hand and trot		177				136
Eel pots	159	247			108	97
Tongs and nippers	287	2,296			527	3,543
Shore and accessory property		17,000		320		27,127
Cash capital		1,200				11,000
Total		174,326		8,605		126,153
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	181,320	$3,513	23,800	$912	34,000	$410
Black bass	7,850	1,953	750	150	600	120
Bluefish	3,350	536				
Butterfish	8,050	1,449				
Carp	54,550	2,521	2,600	190	26,195	2,042
Catfish	26,775	2,488	6,100	295	15,705	837
Crevallé	3,200	96				
Croaker	35,600	1,068			60,600	1,818
Eels, fresh	15,370	1,214			6,900	677
Eels, salted					4,050	405
Flounders	14,950	598			400	22
Hickory shad	500	20				
Mullet	9,800	384	1,000	120	1,220	63
Perch, white	47,750	5,530	3,275	425	8,800	764
Perch, yellow	27,300	3,276	3,035	315	83,820	8,605
Pike or pickerel	8,330	2,084	435	70	1,000	203
Shad	307,300	59,319	79,300	19,435	1,391	299
Spot	20,710	1,036			4,680	300
Squeteagues or "sea trout," fresh	355,600	20,936			8,230	792
Striped bass	459,475	87,587	315	68	24,765	4,953
Sunfish	1,000	10				
Crabs, hard	440,000	19,225			143,125	4,660
Oysters, market, public	953,540	40,866			1,859,900	106,280
Terrapin					205	135
Turtles	500	25			395	19
Total	2,982,820	255,734	120,610	21,980	2,285,981	133,404

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES—Continued.

Items.	St. Marys.		Somerset.		Talbot.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	60		710		273	
On vessels transporting	51		159		72	
In shore fisheries	1,099		1,809		956	
Shoresmen	134		2,585		1,100	
Total	1,344		5,263		2,401	
INVESTMENT.						
Vessels fishing:						
Gasoline	1	$1,050	1	$3,350		
Tonnage	5		13			
Outfit		400		400		
Sail	13	8,150	154	203,925	57	$50,300
Tonnage	91		1,656		414	
Outfit		4,610		42,440		7,533
Vessels transporting:						
Gasoline	3	1,200	37	89,500	17	22,900
Tonnage	25		374		138	
Outfit		1,075		18,612		3,020
Sail	20	29,675	33	55,500	14	33,000
Tonnage	446		675		124	
Outfit		6,655		8,730		1,815
Boats:						
Sail, row, etc	548	16,525	745	95,756	182	7,862
Power	265	62,975	628	195,113	42	105,800
Apparatus, vessel fisheries:						
Scrapes			55	385		
Dredges	28	510	312	8,013	112	2,335
Tongs					2	15
Apparatus, shore fisheries:						
Haul seines	11	1,150			2	280
Gill nets			170	1,173	84	2,631
Pound nets	87	13,835	52	15,725	168	48,100
Fyke nets	2	50	14	1,225	17	205
Dip nets	321	101	722	1,100		
Lines, hand and trot		540		985		1,633
Eel pots	77	122	222	165		
Eel spears			6	12		
Crab scrapes			1,256	8,794		
Dredges	94	2,265	216	5,477	10	275
Tongs and nippers	1,011	7,275	590	4,474	619	4,313
Shore and accessory property		15,665		709,501		305,736
Cash capital		11,400		410,800		119,100
Total		185,228		1,881,155		716,853
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	534,888	$5,257	105,906	$1,913	1,506,865	$26,187
Alewives, salted					682,000	24,052
Black bass			247	37		
Bluefish			1,769	265	7,200	864
Butterfish			8,187	1,228		
Carp	20,125	1,353	300	15	1,165	70
Catfish	33,975	1,716	14,450	1,184	5,705	469
Croaker	80,525	2,215	47,075	993	134,800	4,044
Eels, fresh	3,495	337	17,908	2,475		
Flounders	875	104	16,235	1,022	10,500	525
Gizzard shad	7,900	321				
Menhaden			7,500	30		
Mullet			6,235	374		
Perch, white	11,075	1,373	11,922	418	5,200	461
Perch, yellow	15,850	1,424			6,130	448
Pike or pickerel	450	90	155	20	100	10
Redfish or "red drum"			2,335	35		
Shad	80,750	14,141	37,040	6,939	328,543	60,452
Spanish mackerel			237	36		
Spot	4,900	251	857	60	1,000	50
Squeteagues or "sea trout," fresh	12,325	812	121,123	6,262	8,650	767
Striped bass	101,645	15,304	950	162	55,440	11,088
Sturgeon					510	127
Sturgeon caviar					29	87
Crabs, hard	217,000	7,280	764,229	55,764	1,273,375	42,823
Crabs, soft	105,425	18,495	3,435,915	411,406		
Clams, hard			4,200	1,475		
Oysters, market, public	1,955,345	157,495	4,917,234	526,179	6,731,809	308,854
Oysters, market, private	133,420	8,210	264,124	28,156	29,050	1,245
Terrapin			618	865		
Turtles			800	40		
Total	3,319,968	236,178	9,787,551	1,047,353	10,788,071	482,623

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES—Continued.

Items.	Wicomico.		Worcester		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	9				1,947	
On vessels transporting	26		5		733	
In shore fisheries	528		432		9,859	
Shoresmen	144		27		8,844	
Total	707		464		21,383	
INVESTMENT.						
Vessels fishing:						
Gasoline					14	$11,050
Tonnage					197	
Outfit						2,860
Sail	1	$3,600			402	451,385
Tonnage	34				4,133	
Outfit		130				95,817
Vessels transporting:						
Gasoline	2	4,000			124	231,200
Tonnage	24				1,479	
Outfit		455				44,562
Sail	8	15,650	1	$600	184	352,275
Tonnage	222		7		5,131	
Outfit		1,435		190		41,348
Boats:						
Sail, row, etc	88	2,150	156	3,590	3,264	197,508
Power	183	44,665	123	74,915	3,128	958,598
Apparatus, vessel fisheries:						
Purse seines	1	500			3	900
Scrapes					91	636
Dredges					856	19,728
Tongs					28	382
Apparatus, shore fisheries:						
Purse seines					1	200
Haul seines	1	300			218	24,836
Gill nets	183	4,058	597	14,750	4,247	86,176
Trammel nets					5	533
Pound nets	39	8,900	98	166,060	1,072	390,285
Fyke nets	16	290	145	7,250	3,868	29,827
Bow nets	12	96	25	250	37	346
Dip nets					1,305	1,389
Stop nets					2	125
Otter trawls	1	95			1	95
Lines, hand and trot		285		240		9,399
Slat traps or baskets					1	100
Eel pots	12	12	130	65	4,226	4,128
Eel spears			3	9	9	21
Crab scrapes					1,396	9,774
Dredges					547	13,067
Tongs and nippers	346	2,453	104	738	6,006	44,628
Shore and accessory property		53,942		33,005		3,589,956
Cash capital		33,650		900		953,300
Total		176,666		302,562		7,566,434
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	94,455	$1,459	468,797	$13,696	5,647,388	$114,470
Alewives, salted	15,000	900			1,426,300	62,770
Black bass					77,388	18,969
Black drum					700	8
Bluefish	900	180	58,606	14,652	73,595	16,764
Bonito			46,420	2,785	46,420	2,785
Butterfish			857,000	21,433	875,827	24,302
Carp	460	69	5,500	826	329,450	22,925
Catfish	38,950	4,005	4,800	480	471,207	29,367
Crevallé					3,200	96
Croaker	5,000	500	1,389,180	34,893	2,519,770	66,576
Eels, fresh	1,250	150	4,275	686	170,118	18,936
Eels, salted					31,450	3,145
Flounders	290	53	224,900	11,245	287,765	15,078
Gizzard shad					30,067	913
Goldfish					500	38
Hickory shad					2,100	95
King whiting			9,190	1,741	9,190	1,741
Menhaden					7,500	30
Mullet			66,020	3,301	101,357	5,162
Perch, white	13,381	1,921	4,824	965	321,739	32,991

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MARYLAND IN 1920, BY COUNTIES—Continued.

Items.	Wicomico.		Worcester.		Total.	
PRODUCTS—continued.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Perch, yellow	940	$110	3,200	$640	310,398	$31,452
Pike or pickerel	450	59	2,250	350	64,458	13,688
Pompano			734	147	734	147
Redfish or "red drum"			36,700	551	41,535	627
Scup			101,980	2,611	101,980	2,611
Sea bass			42,980	3,447	42,980	3,447
Shad	85,280	19,413	50,850	11,107	1,867,196	355,217
Sheepshead			51	8	51	8
Spanish mackerel			8,140	1,221	8,477	1,282
Spot	2,300	300	313,067	3,691	364,759	6,829
Squeteagues or "sea trout":						
Fresh	11,930	1,033	1,603,020	48,141	2,274,490	91,514
Salted	7,000	770			7,000	770
Striped bass	13,635	2,619			1,040,274	193,295
Sturgeon			20,706	5,379	21,411	5,551
Sturgeon caviar			2,755	8,663	2,784	8,750
Suckers					2,000	160
Sunfish					5,300	70
Whiting			11,730	234	11,730	234
Yellowtail or "silver perch"					400	40
Crabs, hard	36,167	2,170	96,000	2,160	5,165,703	248,160
Crabs, soft					3,897,271	494,784
Squid			468	29	468	29
Clams, hard			26,000	9,100	30,200	10,575
Oysters, market, public	935,172	80,501	152,894	14,981	29,953,581	2,111,345
Oysters, market, private	878,500	63,750	182,847	41,794	1,878,716	179,775
Terrapin					823	1,000
Turtles					3,045	147
Total	2,141,060	179,962	5,795,884	260,957	59,530,795	4,198,668

FISHERIES BY APPARATUS.

The yield of the vessel fisheries of Maryland in 1920 was 11,868,150 pounds, valued at $881,796, consisting almost wholly of oysters taken with dredges. In the shore fisheries the most productive forms of apparatus were tongs and nippers, with a catch of 17,954,078 pounds of oysters and clams, valued at $1,265,560; pound nets, 13,581,370 pounds, valued at $621,363, the principal species taken being alewives, squeteagues, croakers, shad, and butterfish; lines, chiefly used in the fishery for crabs, 4,825,382 pounds, valued at $234,253; dredges used for taking oysters, 2,287,509 pounds, valued at $181,634; seines, 2,198,816 pounds, valued at $181,291, the more important species taken being alewives, croakers, carp, striped bass, and squeteagues; gill nets, 1,600,462 pounds, valued at $249,297, the more important species taken being shad, alewives, striped bass, and mullet; and scrapes for crabs, 1,454,908 pounds, valued at $286,586.

The products of the vessel fisheries and of the shore fisheries are shown separately, by counties, in the appended tables.

YIELD OF VESSEL FISHERIES OF MARYLAND IN 1920, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Anne Arundel.		Baltimore City.		Calvert.		Charles.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Dredges: Oysters, market, public			746,445	$56,100	180,250	$19,500	29,925	$1,900
Tongs: Oysters, market, public	48,300	$2,850			24,955	2,510		
Grand total	48,300	2,850	746,445	56,100	205,205	22,010	29,925	1,900

Yield of Vessel Fisheries of Maryland in 1920, by Counties, Apparatus, and Species—Continued.

Apparatus and species.	Dorchester.		Kent.		Queen Annes.		St. Marys.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Purse seines:								
Perch, white			400	$48				
Spot			1,000	50				
Squeteagues			48,000	2,480				
Striped bass			40,000	7,200				
Total			89,400	9,778				
Scrapes:								
Crabs, hard	3,798	$315						
Crabs, soft	55,660	6,679						
Total	59,458	6,994						
Dredges: Oysters, market, public	5,201,322	317,043					162,505	$19,550
Tongs: Oysters, market, public					16,800	$960		
Grand total	5,260,780	324,037	89,400	9,778	16,800	960	162,505	19,550

Apparatus and species.	Somerset.		Talbot.		Wicomico.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Purse seines:								
Bluefish					600	$120	600	$120
Croakers					500	50	500	50
Flounders					90	17	90	17
Perch, white							400	48
Spot					800	120	1,800	170
Squeteagues					5,680	568	53,680	3,048
Striped bass					500	125	40,500	7,325
Total					8,170	1,000	97,570	10,778
Scrapes:								
Crabs, hard	6,815	$476					87,195	9,362
Crabs, soft	83,397	9,047					62,475	7,155
Total	90,212	9,523					149,670	16,517
Dredges: Oysters, market, public	2,970,464	317,767	2,217,544	$115,041			11,508,455	846,901
Tongs: Oysters, market, public			22,400	1,280			112,455	7,600
Grand total	3,060,676	327,290	2,239,944	116,321	8,170	1,000	11,868,150	881,796

Yield of Shore Fisheries of Maryland for 1920.

BY SEINES.

Species.	Anne Arundel.		Baltimore.[1]		Calvert.		Caroline.		Cecil.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives, fresh	1,400	$52	6,000	$75	3,200	$80	4,400	$44	10,080	$252
Black bass			2,030	475					29,150	7,288
Carp	25,550	2,084	7,700	710	5,900	365	500	20	57,400	5,870
Catfish	13,050	1,042	15,375	616	16,225	985			9,050	905
Croaker	50,000	2,270	5,000	200	251,425	5,260				
Eels			1,695	171	50	5			250	25
Gizzard shad			3,600	66	2,100	140				
Mullet	2,000	240	175	13	900	100			350	11
Perch, white	810	82	7,265	873	1,935	218	1,730	108	1,600	192
Perch, yellow	2,800	385	5,710	715	4,800	743	635	41	762	73
Pike or pickerel	1,330	258	1,715	415	1,825	405	35	6	8,050	1,218
Shad	570	175					1,714	363	290	67
Spot	1,400	65	450	45	3,600	355				
Squeteagues or "sea trout"	37,000	2,760	12,300	1,395	2,600	180				
Striped bass	5,365	975	23,070	3,907	5,713	1,485	415	83	22,300	4,460
Crabs, hard	50	15								
Crabs, soft	37,625	9,475	6,450	2,900						
Turtles									50	3
Total	178,950	19,878	98,535	12,576	300,273	10,321	9,429	665	139,332	20,364

[1] Includes Baltimore City.

Yield of Shore Fisheries of Maryland for 1920—Continued.

BY SEINES—Continued.

Species.	Charles.		Dorchester.		Harford.		Kent.		Prince Georges.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	150,000	$6,000			211,200	$5,280	20,000	$500	1,400	$52
Alewives, salted					230,400	24,480				
Black bass	12,240	2,879			600	150	600	150		
Carp	38,625	2,392			18,600	930	38,225	1,912	1,700	90
Catfish	33,025	1,349			1,600	160	2,100	39	2,000	100
Croaker	3,570	179	84,000	$2,520			3,500	105		
Eels	375	44								
Gizzard shad	1,250	34								
Goldfish	500	38								
Mullet	775	56					2,800	112	1,000	120
Perch, white	6,835	446	29,360	1,590	3,150	378	4,800	376		
Perch, yellow	25,955	2,086	18,200	910	1,250	150	4,800	576	1,000	130
Pike or pickerel	7,545	1,477			400	100	230	58	100	20
Shad	58,650	11,360	4,200	725	1,120	192			1,930	500
Spot			8,500	420			710	36		
Squeteagues or "sea trout"	1,500	75	2,000	160			41,700	2,502		
Striped bass	8,440	1,616	12,367	2,390	24,000	4,800	65,050	11,829	150	22
Sunfish	200	20								
Total	349,485	30,051	158,627	8,715	492,320	36,620	184,515	18,195	9,280	1,034

Species.	Queen Annes.		St. Marys.		Talbot.		Wicomico.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh									407,680	$12,335
Alewives, salted									230,400	24,480
Black bass									44,620	10,942
Bluefish							300	$60	300	60
Carp	22,270	$1,770	13,550	$1,049	200	$11	100	15	230,320	17,218
Catfish	8,200	389	10,000	459	400	40	250	25	111,275	6,109
Croaker	45,400	1,362	39,400	962	1,100	33	4,500	450	487,895	13,341
Eels	650	65	170	17					3,190	327
Flounders	200	12	75	6			200	36	475	54
Gizzard shad			5,300	232					12,250	472
Goldfish									500	38
Mullet									8,000	652
Perch, white	4,800	305	4,975	661			700	105	67,960	5,334
Perch, yellow	32,270	3,077	3,400	450	3,500	280	200	30	105,282	9,646
Pike or pickerel	450	68							21,680	4,025
Shad									68,474	13,382
Spot	4,600	296	2,950	158			1,500	180	23,710	1,555
Squeteagues or "sea trout"	8,180	788	4,300	226			1,800	180	111,380	8,266
Striped bass	23,925	4,785	26,200	3,785	850	170	1,000	200	218,845	40,507
Sunfish									200	20
Crabs, hard									50	15
Crabs, soft									44,075	12,375
Turtles									50	3
Terrapin	205	135							205	135
Total	151,150	13,052	110,320	8,005	6,050	534	10,550	1,281	2,198,816	181,291

BY GILL NETS.

Species.	Anne Arundel.		Baltimore.[1]		Calvert.		Caroline.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			1,000	$20			9,820	$98
Black bass	100	$31						
Carp							50	3
Catfish	5,300	310					425	41
Perch, white	1,195	155	3,565	404	1,200	$160	650	43
Perch, yellow	3,225	525						
Pike or pickerel	790	210						
Shad	8,000	2,480	110	30	4,500	780	13,341	2,828
Squeteagues or "sea trout"			11,050	1,150				
Striped bass	400	100	35,580	5,710			730	137
Total	19,010	3,811	51,305	7,314	5,700	940	25,016	3,150

[1] Includes Baltimore City.

YIELD OF SHORE FISHERIES OF MARYLAND FOR 1920—Continued.

BY GILL NETS—Continued.

Species.	Cecil.		Charles.		Dorchester.		Harford.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives	30,400	$760	30,000	$1,200	14,500	$145	36,720	$918
Black bass	40	10					1,000	250
Bluefish					1,460	215		
Carp	14,675	740					3,350	168
Catfish	1,350	136			180	18	4,200	420
Mullet	833	25					200	10
Perch, white					1,530	108	250	30
Perch, yellow					550	33	2,000	240
Pike or pickerel	60	15					1,500	375
Shad	107,016	18,272	128,000	27,100	6,975	1,454	52,476	8,625
Striped bass	45,505	9,101			1,811	355	32,050	6,410
Total	199,879	29,059	158,000	28,300	27,006	2,328	133,746	17,446

Species.	Kent.		Prince Georges.		Queen Annes.		Somerset.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives	7,680	$192			10,000	$125		
Black bass	50	13						
Bluefish							1,769	$265
Carp	3,450	174						
Catfish	2,575	238						
Croaker	750	22						
Flounders	150	6						
Mullet							6,235	374
Perch, white	5,900	708						
Perch, yellow	2,500	300						
Pike or pickerel	2,200	550						
Shad	303,100	58,599	75,500	$18,485			11,237	1,956
Spanish mackerel							237	36
Squeteagues or "sea trout"	200	12						
Striped bass	164,750	30,645						
Total	493,305	91,459	75,500	18,485	10,000	125	19,478	2,631

Species.	Talbot.		Wicomico.		Worcester.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives	3,600	$52	41,500	$815	125,743	$3,772	310,963	$8,097
Black bass							1,190	304
Bluefish	7,200	864					10,429	1,344
Carp	75	6			5,500	826	27,100	1,917
Catfish	430	39	4,500	450	4,800	480	23,760	2,132
Croaker							750	22
Flounders							150	6
King whiting					1,850	273	1,850	273
Mullet					66,020	3,301	73,288	3,710
Perch, white	600	50	2,950	436	1,950	390	19,790	2,484
Perch, yellow	75	6	100	14	3,200	640	11,650	1,758
Pike or pickerel			450	59	2,250	350	7,250	1,559
Sea bass					1,680	143	1,680	143
Shad	7,150	1,536	63,614	14,823	6,250	1,112	787,269	158,080
Spanish mackerel							237	36
Squeteagues or "sea trout"	2,200	176					13,450	1,338
Striped bass	1,115	223	6,700	1,340			288,641	54,021
Sturgeon					18,680	4,670	18,680	4,670
Sturgeon caviar					2,335	7,403	2,335	7,403
Total	22,445	2,952	119,814	17,937	240,258	23,360	1,600,462	249,297

BY POUND NETS.

Species.	Anne Arundel.		Baltimore.[1]		Calvert.		Caroline.		Cecil.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	300,200	$5,405	4,200	$208	243,840	$4,445	3,450	$35	649,400	$17,615
Alewives, salted					21,000	1,250			477,900	12,088
Black bass			270	70					8,750	2,188
Bluefish	90	10			50	10				
Butterfish					675	55				

[1] Includes Baltimore City.

YIELD OF SHORE FISHERIES OF MARYLAND FOR 1920—Continued.

BY POUND NETS—Continued.

Species.	Anne Arundel.		Baltimore.		Calvert.		Caroline.		Cecil.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Carp	7,950	$479	242	$16	610	$40			6,055	$304
Catfish	2,950	117	24,050	1,015	8,500	545	450	$40	19,556	1,231
Croaker	32,175	1,057			27,375	865				
Eels	4,100	355	1,260	115	500	50			400	40
Flounders	4,350	430			3,965	500				
Gizzard shad	4,175	90	2,100	40	1,000	20				
Hickory shad					600	25			1,000	50
Mullet			160	16	50	10			6,204	186
Perch, white	8,460	848	11,515	1,712	9,900	1,070	1,371	96	19,850	2,380
Perch, yellow	3,820	495	1,865	280	720	105	40	3	17,135	2,056
Pike or pickerel	685	146	635	130					2,760	698
Shad	27,322	5,987			70,180	12,796	1,115	239	57,288	9,518
Spanish mackerel					100	25				
Spot	1,025	75			1,410	126				
Squeteagues or "sea trout":										
Fresh	40,625	3,295	8,985	745	6,085	555				
Striped bass	41,060	6,188	6,360	985	6,945	1,530	575	115	14,050	2,810
Sunfish									400	4
Crabs, hard	8,050	325								
Total	487,037	25,302	61,642	5,332	403,505	24,022	7,001	528	1,280,748	51,168

Species.	Charles.		Dorchester.		Harford.		Kent.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	190,900	$5,120	579,282	$8,677	185,200	$3,883	152,000	$2,780
Black bass	50	12	3,210	785	240	63		
Black drum			700	8				
Bluefish			50	8			3,350	536
Butterfish			1,915	137			8,050	1,449
Carp	6,150	353	7,685	355	700	35	950	48
Catfish	33,375	1,702	44,200	2,375	680	68	3,250	326
Crevalle							3,200	96
Croaker	13,900	491	293,825	7,897			30,350	911
Eels			440	53	1,400	98	3,220	225
Flounders			11,300	579			14,800	592
Gizzard shad	1,500	30	4,917	140				
Hickory shad							500	20
Mullet	20	1	150	12	490	22		
Perch, white	18,800	1,615	22,087	1,855	2,000	240	20,450	2,454
Perch, yellow	21,700	1,730	13,000	829	1,700	204	1,900	228
Pike or pickerel	1,500	314	4,613	921	215	54	500	125
Redfish or red drum			2,500	41				
Shad	3,374	767	337,708	58,041	9,810	1,682	4,200	720
Spot	360	25					19,000	950
Squeteagues or "sea trout":								
Fresh	3,500	270	23,990	1,808			265,600	15,936
Striped bass	16,400	2,964	68,283	12,885	2,850	570	180,800	36,160
Sturgeon	45	15	150	30				
Total	311,574	15,409	1,420,005	97,436	205,285	6,919	712,120	63,556

Species.	Prince Georges.		Queen Annes.		St. Marys.		Somerset.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	22,400	$860	24,000	$285	534,888	$5,257	98,779	$1,810
Butterfish							8,187	1,228
Carp			250	17	6,575	304	300	15
Catfish	1,100	65			23,775	1,247	9,950	804
Croaker			15,200	456	40,950	1,243	29,550	566
Eels					1,875	196	243	34
Flounders			200	10	750	95	[2] 14,905	982
Gizzard shad					2,600	89		
Menhaden							7,500	30
Perch, white	3,275	425	1,250	230	5,500	663	1,792	215
Perch, yellow	335	50	9,650	1,753	12,210	955		
Pike or pickerel					450	90		
Redfish or red drum							2,335	35
Shad	1,870	450	1,391	299	80,750	14,141	25,043	4,850
Spot			80	4	1,950	93		
Squeteagues or "sea trout":								
Fresh			50	4	7,200	536	103,356	5,459
Striped bass	165	46	530	106	75,445	11,519	650	117
Total	29,145	1,896	52,601	3,164	794,918	36,428	302,590	16,145

[2] Includes 13,370 pounds salted flounders, valued at $936.

YIELD OF SHORE FISHERIES OF MARYLAND FOR 1920—Continued.

BY POUND NETS—Continued.

Species.	Talbot.		Wicomico.		Worcester.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	1,502,615	$26,125	46,670	$539	208,384	$5,884	4,746,208	$88,928
Alewives, salted	682,000	24,052	15,000	900			1,195,900	38,290
Black bass							12,520	3,118
Black drum							700	8
Bluefish					2,936	734	6,476	1,298
Bonito					25,020	1,501	25,020	1,501
Butterfish					857,000	21,433	875,827	24,302
Carp	800	48	300	45			38,567	2,059
Catfish	4,610	369	10,300	1,030			186,746	10,934
Crevallé							3,200	96
Croaker	133,700	4,011			1,311,280	32,774	1,928,305	50,271
Eels							13,438	1,166
Flounders	10,500	525			215,600	10,780	276,370	14,493
Gizzard shad							16,292	409
Hickory shad							2,100	95
King whiting					7,340	1,468	7,340	1,468
Menhaden							7,500	30
Mullet							7,074	247
Perch, white	3,300	281	4,860	650			134,410	14,734
Perch, yellow	2,340	145	75	11			86,490	8,844
Pike or pickerel	100	10					11,458	2,488
Pompano					734	147	734	147
Redfish or red drum					36,700	551	41,535	627
Scup					73,400	1,468	73,400	1,468
Shad	321,053	58,845	21,666	4,590	32,100	7,770	994,870	180,695
Sheepshead					51	8	51	8
Spanish mackerel					8,140	1,221	8,240	1,246
Spot	1,000	50			313,067	3,691	337,892	5,014
Squeteagues or "sea trout":								
Fresh	6,450	591	4,000	240	1,571,200	47,136	2,041,041	76,575
Salted			7,000	770			7,000	770
Striped bass	53,300	10,660	3,425	559			470,838	87,214
Sturgeon	510	127			2,026	709	2,731	881
Sturgeon caviar	29	87			420	1,260	449	1,347
Sunfish							400	4
Whiting					11,730	234	11,730	234
Squid					468	29	468	29
Crabs, hard							8,050	325
Total	2,722,307	125,926	113,296	9,334	4,677,596	138,798	13,581,370	621,363

BY TRAMMEL NETS.

Species.	Anne Arundel.		Cecil.		Harford.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			2,000	$50			2,000	$50
Black bass			3,000	750			3,000	750
Carp			900	45	1,000	$50	1,900	95
Catfish			650	65	200	20	850	85
Mullet					100	30	100	30
Perch, white	350	$35			100	12	450	47
Perch, yellow	1,500	150			200	24	1,700	174
Pike or pickerel	800	200	1,500	325			2,300	525
Striped bass	115	25	200	40	4,200	840	4,515	905
Total	2,765	410	8,250	1,275	5,800	976	16,815	2,661

BY FYKE NETS.

Species.	Anne Arundel.		Baltimore.[1]		Caroline.		Cecil.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			4,545	$170	2,200	$22	640	$16
Black bass			576	122			5,500	1,376
Carp			320	35	200	16	6,200	334
Catfish	14,850	$710	41,346	1,649	830	78	13,800	1,370
Eels, fresh			3,612	318			8,735	884
Gizzard shad	1,000	20	525	12				
Mullet			825	70			3,750	113
Perch, white	1,075	130	18,593	1,812	5,000	330	31,150	3,738
Perch, yellow	2,460	350	7,026	841	650	45	24,650	2,958

[1] Includes Baltimore City.

Yield of Shore Fisheries of Maryland for 1920—Continued.

BY FYKE NETS—Continued.

Species.	Anne Arundel.		Baltimore.		Caroline.		Cecil.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pike or pickerel	425	$85	3,055	$639			7,300	$1,826
Shad					1,257	$284	600	105
Squeteagues or "sea trout"			57	6				
Striped bass			75	15	750	135	3,050	610
Suckers							1,000	80
Sunfish			200	1			3,500	35
Turtles							300	15
Total	19,810	1,295	80,755	5,690	10,887	910	110,175	13,460

Species.	Charles.		Dorchester.		Harford.		Kent.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			1,700	$17			1,640	$41
Black bass	485	$85			700	$175	7,200	1,790
Carp	4,750	142					11,925	387
Catfish	16,300	666	300	30	2,500	225	18,850	1,885
Croaker							1,000	30
Eels, fresh	320	26			100	7	5,250	461
Mullet					100	5	7,000	272
Perch, white	330	23	146	22	2,900	348	16,200	1,944
Perch, yellow	4,800	310	160	16	2,800	336	18,100	2,171
Pike or pickerel	2,650	510			1,900	475	5,400	1,352
Squeteagues or "sea trout"							100	6
Striped bass	200	40					8,875	1,753
Sunfish							1,000	10
Turtles							500	25
Total	29,835	1,802	2,306	85	11,000	1,571	103,040	12,127

Species.	Prince Georges.		Queen Annes.		St. Marys.		Somerset.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives							7,127	$103
Black bass	750	$150	600	$120			247	37
Carp	900	100	3,675	255				
Catfish	3,000	130	7,505	448	200	$10	4,500	380
Croaker							7,025	217
Eels, fresh			900	77				
Eels, salted			250	25				
Flounders					50	3		
Mullet			1,220	63				
Perch, white			2,750	229	100	9	930	111
Perch, yellow	1,700	135	41,900	3,775	240	19		
Pike or pickerel	335	50	550	135			155	20
Shad							760	133
Squeteagues or "sea trout"							4,617	277
Striped bass			310	62			300	45
Turtles			395	19			800	40
Total	6,685	565	60,055	5,208	590	41	26,461	1,363

Species.	Talbot.		Wicomico.		Worcester.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives	650	$10	6,285	$105	134,670	$4,040	159,457	$4,524
Black bass							16,058	3,855
Carp	90	5					28,060	1,274
Catfish	265	21	1,900	190			126,146	7,792
Croaker					70,300	1,929	78,325	2,176
Eels, fresh							18,917	1,773
Eels, salted							250	25
Flounders							50	3
Gizzard shad							1,525	32
Mullet							12,895	523
Perch, white	1,300	130	605	90	2,874	575	83,953	9,491
Perch, yellow	215	17	65	10			104,766	10,984
Pike or pickerel							21,770	5,091
Shad	340	71					2,957	593
Squeteagues or "sea trout"			450	45	26,670	850	31,894	1,184
Striped bass	175	35	525	105			14,260	2,800
Suckers							1,000	80
Sunfish							4,700	46
Turtles							1,995	99
Total	3,035	289	9,830	545	234,514	7,394	708,978	52,345

YIELD OF SHORE FISHERIES OF MARYLAND FOR 1920—Continued.

BY OTTER TRAWLS, STOP NETS, SLAT TRAPS OR BASKETS, BOW NETS, AND HAND.

Apparatus and species.	Anne Arundel.		Harford.		Somerset.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Stop nets: Carp	3,000	$330				
Slat traps or baskets:						
Alewives			20,000	$500		
Carp			443	23		
Catfish			430	5		
Eels			100	10		
Shad			558	107		
Striped bass			100	20		
Suckers			1,000	80		
Total			22,631	745		
Hand: Terrapin					618	$865

Apparatus and species.	Wicomico.		Worcester.		Total.	
Otter trawls:	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Catfish	4,000	$400			4,000	$400
Carp	60	9			60	9
Perch, white	2,000	300			2,000	300
Perch, yellow	500	45			500	45
Striped bass	100	20			100	20
Total	6,660	774			6,660	774
Stop nets: Carp					3,000	330
Slat traps or baskets:						
Alewives					20,000	500
Carp					443	23
Catfish					430	5
Eels					100	10
Shad					558	107
Striped bass					100	20
Suckers					1,000	80
Total					22,631	745
Bow nets:						
Catfish	1,300	130			1,300	130
Perch, white	2,266	340			2,266	340
Shad			12,500	$2,225	12,500	2,225
Striped bass	1,385	270			1,385	270
Total	4,951	740	12,500	2,225	17,451	2,965
Hand: Terrapin					618	865

BY LINES.

Species.	Anne Arundel.		Baltimore.[1]		Calvert.		Charles.		Dorchester.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish									120	$24
Croaker	2,000	$120			600	$30			3,120	156
Eels									50	6
Perch, white	500	50							310	31
Perch, yellow									10	1
Spot	500	30								
Squeteagues or "sea trout"	1,200	100			100	10			2,620	262
Striped bass	300	65			100	10			690	138
Yellowtail or "silver perch"									400	40
Crabs, hard	753,095	30,730	77,730	$4,105	73,125	2,800	137,575	$4,815	1,128,557	70,004
Crabs, soft	8,000	3,225	820	325					7,897	947
Turtles							1,000	45		
Total	765,595	34,320	78,550	4,430	73,925	2,850	138,575	4,860	1,143,774	71,609

[1] Includes Baltimore City.

YIELD OF SHORE FISHERIES OF MARYLAND FOR 1920—Continued.

BY LINES—Continued.

Species.	Harford.		Kent.		Queen Annes.		St. Marys.		Somerset.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Croaker							175	$10	10,500	$210
Flounders									1,330	40
Perch, white							500	40	9,200	92
Spot									857	60
Squeteagues or "sea trout"							825	50	13,150	526
Crabs, hard	6,000	$300	440,000	$19,225	143,125	$4,660	217,000	7,280	191,059	14,299
Total	6,000	300	440,000	19,225	143,125	4,660	218,500	7,380	226,096	15,227

Species.	Talbot.		Wicomico.		Worcester.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					55,670	$13,918	55,790	$13,942
Bonito					21,400	1,284	21,400	1,284
Catfish			16,700	$1,780			16,700	1,780
Croaker					7,600	190	23,995	716
Eels							50	6
Flounders					9,300	465	10,630	505
Perch, white							10,510	213
Perch, yellow							10	1
Scup					28,580	1,143	28,580	1,143
Sea bass					41,300	3,304	41,300	3,304
Spot							1,357	90
Squeteagues or "sea trout"					5,150	155	23,045	1,103
Striped bass							1,090	213
Yellowtail or "silver perch"							400	40
Crabs, hard	1,273,375	$42,823	36,167	2,170	96,000	2,160	4,572,808	205,371
Crabs, soft							16,717	4,497
Turtles							1,000	45
Total	1,273,375	42,823	52,867	3,950	265,000	22,619	4,825,382	234,253

BY DIP NETS, EEL POTS, AND SPEARS.

Apparatus and species.	Anne Arundel.		Baltimore.[1]		Calvert.		Cecil.		Charles.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Dip nets:										
Alewives							360	$18		
Shad							568	135		
Crabs, soft	55,187	$15,460			32,058	$7,095				
Total	55,187	15,460			32,058	7,095	928	153		
Eel pots:										
Eels, fresh	6,000	600	11,450	$1,060			400	40	5,650	$710
Total	6,000	600	11,450	1,060			400	40	5,650	710

Apparatus and species.	Dorchester.		Harford.		Kent.		Queen Annes.		St. Marys.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Dip nets:										
Alewives			720	$18						
Crabs, hard	4,902	$442								
Crabs, soft	21,735	2,648							105,425	$18,495
Total	26,637	3,090	720	18					105,425	18,495
Eel pots:										
Eels, fresh	70,833	8,460	3,200	320	6,900	$528	5,350	$535	1,450	124
Eels, salted	27,400	2,740					3,800	380		
Total	98,233	11,200	3,200	320	6,900	528	9,150	915	1,450	124

[1] Includes Baltimore City.

YIELD OF SHORE FISHERIES OF MARYLAND FOR 1920—Continued.

BY DIP NETS, EEL POTS, AND SPEARS—Continued.

Apparatus and species.	Somerset.		Wicomico.		Worcester.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Dip nets:								
Alewives							1,080	$36
Shad							568	135
Crabs, hard	395,984	$28,892					400,886	29,334
Crabs, soft	1,201,405	144,226					1,415,810	187,924
Total	1,597,389	173,118					1,818,344	217,429
Eel pots:								
Eels, fresh	9,393	1,309	1,250	$150	2,150	$430	124,026	14,266
Eels, salted							31,200	3,120
Total	9,393	1,309	1,250	150	2,150	430	155,226	17,386
Spears: Eels, fresh	8,272	1,132			2,125	256	10,397	1,388

BY SCRAPES, DREDGES, TONGS, AND NIPPERS.

Apparatus and species.	Anne Arundel.		Calvert.		Charles.		Dorchester.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Scrapes:								
Crabs, hard							2,925	$227
Crabs, soft							130,499	16,129
Total							133,424	16,356
Dredges: Oysters, market, public					29,750	$2,265	1,073,436	75,756
Tongs and nippers:								
Oysters, market, public	2,006,200	$121,876	750,505	$79,560	343,700	26,100	2,012,899	170,729
Oysters, market, private	23,450	1,990	105,525	12,250	102,900	7,625	158,900	14,755
Total	2,029,650	123,866	856,030	91,810	446,600	33,725	2,171,799	185,484

Apparatus and species.	Kent.		Queen Annes.		St. Marys.		Somerset.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Scrapes:								
Crabs, hard							170,371	$12,097
Crabs, soft							2,151,113	258,133
Total							2,321,484	270,230
Dredges: Oysters, market, public					487,620	$35,045	614,313	65,012
Tongs and nippers:								
Oysters, market, public	953,540	$40,866	1,843,100	$105,320	1,305,220	102,900	1,332,457	143,400
Oysters, market, private					133,420	8,210	264,124	28,156
Clams, hard							4,200	1,475
Total	953,540	40,866	1,843,100	105,320	1,438,640	111,110	1,600,781	173,031

Apparatus and species.	Talbot.		Wicomico.		Worcester.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Scrapes:								
Crabs, hard							173,296	$12,324
Crabs, soft							2,281,612	74,262
Total							1,454,908	286,586
Dredges: Oysters, market, public	82,390	$3,556					2,287,509	181,634
Tongs and nippers:								
Oysters, market, public	4,409,475	188,977	935,172	$80,501	152,894	$14,981	16,045,162	1,075,210
Oysters, market, private	29,050	1,245	878,500	63,750	182,847	41,794	1,878,716	179,775
Clams, hard					26,000	9,100	30,200	10,575
Total	4,438,525	190,222	1,813,672	144,251	361,741	65,875	17,954,078	1,265,560

INDUSTRIES.

Salt-fish industry.—Alewives are the only species of importance salted in Maryland, the output in 1920 amounting to 1,957,717 pounds, valued at $69,483. The number of firms engaged was as follows: In Talbot County, 7; in Dorchester and Harford, 2 each; and in St. Marys and Somerset Counties, one each. Squeteagues to the value of $2,500 were also salted by a firm in another county.

Canning industry.—The pack of fishery products in cans in Maryland in 1920 amounted to 185,765 cases, valued at $851,576, of which 172,674 cases, valued at $784,569, were canned oysters. Small quantities of alewives and roe and squeteague roe were also canned. Of the total pack of canned fishery products, 147,516 cases, valued at $640,811, are credited to Baltimore City.

By-products.—The most important source of by-products in Maryland is the oyster shell-crushing industry, which yielded 45,756 tons of poultry grit, valued at $617,952, and 23,403 tons of lime, valued at $187,899. This industry is confined largely to Baltimore City. In addition there were produced 571 tons of dry scrap, valued at $21,855, and fish oil to the value of $600.

Wholesale trade.—In 1920 there were 345 wholesale fishery establishments in Maryland, valued at $3,460,653, with a cash capital amounting to $945,750, and engaging 8,502 persons, to whom $2,147,830 were paid in wages.

The important features of each of the above shore industries are shown in the appended tables.

QUANTITY AND VALUE OF FISHERY PRODUCTS CANNED IN MARYLAND IN 1920.

Products canned.	Baltimore City.		Remainder of State.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Oysters:						
4-ounce (4 dozen to case)..............cases..	16,333	$45,898	5,000	$31,800	21,333	$77,698
5-ounce (4 dozen to case)..............do....	82,043	340,858	18,844	105,177	100,887	446,035
6-ounce (4 dozen to case)..............do....	11,505	50,202			11,505	50,202
7-ounce (2 dozen to case)..............do....			262	900	262	900
8-ounce (2 dozen to case)..............do....	5,679	29,030			5,679	29,030
10-ounce (2 dozen to case)..............do....	31,856	174,063	1,052	5,881	32,908	179,944
12-ounce (2 dozen to case)..............do....	100	760			100	760
Total....................................	147,516	640,811	25,158	143,758	172,674	784,569
Alewife roe:						
No. 1 (4 dozen to case)................cases..			6,624	42,143	6,624	42,143
No. 2 (2 dozen to case)................do....			4,791	21,177	4,791	21,177
Total....................................			11,415	63,320	11,415	63,320
Alewives and squeteague roe Nos. 1 and 2,[1] cases....................................			1,676	3,687	1,676	3,687
Grand total..............................	147,516	640,811	38,249	210,765	185,765	851,576

[1] No. 1 cans are packed four dozen to a case and No. 2 cans two dozen to a case.

QUANTITY AND VALUE OF BY-PRODUCTS MANUFACTURED FROM FISHERY PRODUCTS IN BALTIMORE CITY AND VARIOUS COUNTIES IN MARYLAND IN 1920.

By-products.	Baltimore City.		Anne Arundel County.		Dorchester County.		Charles, Somerset, Talbot, and Wicomico Counties.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Ground oyster shells:										
Poultry grit..tons..	40,368	$566,072	....	....	....	....	[1] 5,388	$51,880	45,756	$617,952
Lime.........do....	14,264	116,924	1,560	$4,840	2,464	$14,867	5,115	51,268	23,403	187,899
Dry scrap........do....	....	....	....	....	....	....	[2] 571	21,855	[2] 571	21,855
Oil from fish waste.....	....	....	....	....	....	....	....	600	....	600
Total............	....	682,996	....	4,840	....	14,867	....	125,603	....	828,306

[1] Represents output of one plant each in Dorchester, Somerset, and Talbot Counties.
[2] Represents output of one plant in Dorchester, two plants in Somerset, and one plant in Talbot County, made from crab waste and fish cuttings.

INVESTMENT, PERSONS ENGAGED, AND WAGES PAID IN THE WHOLESALE FISHERY TRADE OF MARYLAND, 1920, BY LOCALITIES.

Localities.	Establishments.		Cash capital.	Number of persons engaged.	Wages paid.
	Number.	Value.			
Baltimore	78	$1,885,447	$146,450	2,015	$894,492
Crisfield, Lawsonia, and Smith Island	95	601,236	329,250	1,953	512,525
Cambridge	17	231,978	121,000	1,079	199,005
Oxford and Bellevue	12	137,071	33,900	349	53,842
St. Michaels and Claiborne	7	84,090	39,100	358	74,721
Tilghman Island	12	74,885	45,200	352	58,381
Annapolis and Eastport	11	58,535	16,300	297	65,516
Deal Island and Chance	15	38,059	50,650	425	51,543
Chester and Rock Hall	16	34,737	12,200	249	43,470
Hoopers Island	10	44,785	25,800	184	42,449
Bishops Head, Wingate, and Toddville	10	24,034	8,750	260	13,679
Mount Vernon and Marion	4	28,224	24,000	176	28,732
Wynne, Airedale, and Cornfield Harbor	5	5,900	4,400	73	16,550
Rock Point and Blackistone	3	34,350	4,500	91	16,575
Galloway	4	8,550	4,100	57	14,600
Whitehaven, Nanticoke, and Bivalve	4	7,620	3,650	134	14,700
Taylor Island	4	20,171	16,600	118	9,880
Havre de Grace, Perryville, and North East	5	9,900	1,900	43	6,792
Solomons, Plum Point, and Benedict	6	11,470	5,700	52	5,700
Fairmount, Inverness, and Rumbley	4	24,699	6,900	31	5,136
Shadyside	4	5,305	2,800	32	4,200
Mayo and Deale	3	37,100	4,200	92	2,925
Miscellaneous localities	16	52,507	38,400	82	12,417
Total	345	3,460,653	945,750	8,502	2,147,830

FISHERIES OF VIRGINIA.

In 1920 the number of persons engaged in the fisheries and related industries of Virginia was 19,378, of whom 1,995 were on fishing vessels, 563 on vessels transporting fishery products, 11,612 in the shore or boat fisheries, and 5,208 in the wholesale fishery trade, canning establishments, etc.

The amount of capital invested amounted to $10,709,499, which includes 448 fishing and transporting vessels, valued at $3,222,700, with a net tonnage of 9,883 tons and outfits valued at $704,068; 8,880 boats, valued at $1,188,136; fishing apparatus with a value of $1,255,891; shore and accessory property to the value of $3,561,449; and cash capital to the amount of $777,255.

The products of the fisheries amounted to 471,219,089 pounds, valued at $8,541,724. The species of chief importance arranged in the order of their value were as follows: Oysters, 27,744,983 pounds, or 3,963,569 bushels, valued at $2,349,161; menhaden, 366,379,425 pounds, valued at $2,158,518; shad, 7,293,805 pounds, valued at $1,145,106; squeteagues, or "sea trout," 12,908,502 pounds, valued at $654,521; crabs, 13,637,079 pounds, valued at $565,564; croaker, 16,372,134 pounds, valued at $513,975; alewives, 16,665,100 pounds, valued at $259,258; clams, 499,440 pounds, valued at $229,645; and butterfish, 3,018,842 pounds, valued at $136,894.

Compared with 1904 there was a decrease in the number of persons employed in the fisheries of Virginia of 9,490, or 32.87 per cent, but increases in the investment amounting to $6,094,565, or 132.06 per cent, in the quantity of products amounting to 115,903,291 pounds, or 32.61 per cent, and in the value of the products amounting to $2,957,370, or 52.95 per cent.

For comparative purposes the products of certain of the important fisheries of the State for various years beginning with 1890 are shown in the following table. It will be noted from an examination of this table that the catch of shad, alewives, and squeteagues has fluctuated to a lesser degree than the catch of the other important species. There has been a marked increase in the catch of butterfish, croaker, and menhaden, but a decrease in the catch of crabs and oysters.

PRODUCTS OF CERTAIN FISHERIES OF VIRGINIA, VARIOUS YEARS, 1890 TO 1921.

Species.	1890	1891	1897	1901	1904
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Alewives	10,641,698	11,013,485	13,689,510	13,913,444	14,603,866
Butterfish	138,753	120,000	465,828	1,071,860	1,335,391
Croaker	1,124,525	1,075,690	4,161,529	3,937,168	3,842,709
Menhaden	107,341,713	105,980,334	178,656,362	273,493,799	247,918,766
Shad	7,266,207	6,498,242	11,529,474	6,972,212	7,419,899
Squeteagues or "sea trout"	4,072,304	3,929,899	6,525,806	7,431,496	6,951,068
Crabs	3,025,104	2,794,027	6,399,514	7,401,701	12,266,706
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Oysters	6,074,025	6,162,086	7,023,848	6,067,669	7,612,289

Species.	1908	1915	1920	1921
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Alewives	37,885,000	16,054,130	16,665,100	18,834,164
Butterfish	725,000		3,018,842	
Croaker	4,839,000		16,372,134	
Menhaden	190,089,000		366,379,425	
Shad	7,314,000	4,714,134	7,293,805	6,936,001
Squeteagues or "sea trout"	4,491,000		12,908,502	
Crabs	25,083,000	20,249,386	13,637,079	
	Bushels.	*Bushels.*	*Bushels.*	
Oysters	5,075,000	[1] 6,206,098	3,963,569	

[1] The statistics for oysters are for 1912.

FISHERIES BY COUNTIES.

The following table shows the number of persons engaged, investment, and products of the fisheries of Virginia, by counties, in 1920:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES.

Items.	Accomac.		Arlington.		Caroline.		Charles City.	
PERSONS ENGAGED	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	237							
On vessels transporting	116		5					
In shore fisheries	1,481		149		25		256	
Shoresmen	768							
Total	2,602		154		25		256	
INVESTMENT.								
Vessels fishing, steam	4	$253,869						
Tonnage	412							
Outfit		41,262						
Vessels fishing, gasoline	6	11,100						
Tonnage	67							
Outfit		3,698						
Vessels fishing, sail	15	11,625						
Tonnage	116							
Outfit		7,347						
Vessels transporting, gasoline	42	63,950	2	$6,100				
Tonnage	391		18					
Outfit		13,516		775				
Vessels transporting, sail	10	19,250						
Tonnage	203							
Outfit		2,875						
Boats, sail, row, etc	981	59,485	53	3,175	15	$300	158	$3,950
Boats, power	684	235,115	44	9,525			6	1,400
Apparatus, vessel fisheries:								
Purse seines	5	8,400						
Crab scrapes	24	172						
Oyster dredges	40	860						
Apparatus, shore fisheries:								
Haul seines	12	910	5	460			1	300
Gill nets	721	18,005	64	8,375	94	480	154	8,085
Pound nets and weirs	309	245,112			3	450		
Fyke nets	7	405	55	380	2	40	26	300
Dip nets	330	359						
Otter trawls	1	125						
Lines, hand and trot		1,595						
Eel pots	3	2					10	20
Crab scrapes	531	3,784						
Crab dredges	38	456						
Crab traps	13	18						
Tongs, rakes, and hoes	1,106	8,167						
Oyster dredges	110	1,775						
Scallop dredges	198	1,464						
Shore and accessory property		301,367		400				100
Cash capital		150,105						
Total		1,466,173		29,190		1,270		14,155
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	839,724	$12,524			10,800	$342	109,000	$1,680
Black drum	59,480	787						
Bluefish	57,595	9,837						
Bonito	134,750	8,413						
Butterfish	765,270	35,125						
Carp			1,795	$160	280	14	25,700	2,020
Catfish			16,300	795	500	25	22,200	1,688
Croaker	2,814,745	104,739						
Eels	5,550	1,350					2,000	120
Flounders	60,710	2,569						
Goldfish			4,050	380				
Hickory shad	4,120	211			4,500	180		
King whiting	15,443	1,280						
Mackerel	70,417	8,450						
Menhaden	41,280,950	259,116						
Mullet	223,163	4,555	1,820	185				
Perch, white			1,325	123	2,070	194	5,020	498
Perch, yellow			2,150	175			500	50
Pigfish	25,600	600						

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Accomac.		Arlington.		Caroline.		Charles City.	
PRODUCTS—continued.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pompano	4,200	$1,000						
Redfish or red drum	87,510	3,365						
Scup	12,625	600						
Sea bass	10,375	830						
Shad	416,667	77,172	80,282	$15,288	7,682	$989	306,500	$56,770
Sheepshead	30	6						
Spanish mackerel	18,630	2,720						
Spot	136,521	3,943						
Squeteagues or "sea trout"	4,241,097	210,195						
Striped bass	17,394	1,225	140	35	500	100	300	60
Sturgeon	10,579	3,319						
Sturgeon caviar	1,375	4,685						
Crabs, hard	776,475	32,616						
Crabs, soft	944,807	120,688						
Squid	42,150	1,475						
Clams, hard	325,176	169,897						
Oysters, market, public	1,126,643	111,984						
Oysters, market, private	1,998,997	203,120						
Oysters, seed, public	213,500	8,825						
Oysters, seed, private	140,000	2,450						
Scallops	101,760	21,352						
Terrapin	248	360						
Turtles	780	39						
Cabomba			900	90				
Total	56,985,056	1,431,422	108,762	17,231	26,332	1,844	471,220	62,886

Items.	Chesterfield.		Dinwiddie.		Elizabeth City.		Essex.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing					78			
On vessels transporting					24			
In shore fisheries	23		40		367		222	
Shoresmen					527		31	
Total	23		40		996		253	
INVESTMENT.								
Vessels, fishing, steam					2	$20,000		
Tonnage					39			
Outfit						5,200		
Vessels fishing, gasoline					19	78,500		
Tonnage					177			
Outfit						21,695		
Vessels transporting, gasoline					5	12,500		
Tonnage					64			
Outfit						1,550		
Vessels transporting, sail					5	8,200		
Tonnage					157			
Outfit						825		
Boats, sail, row, etc	11	$300	20	$500	68	2,060	86	$2,500
Boats, power	1	200	1	100	100	44,650	33	8,300
Apparatus, vessel fisheries:								
Crab dredges					26	1,140		
Oyster dredges					28	1,155		
Apparatus, shore fisheries:								
Haul seines			1	200			3	225
Gill nets	11	825	40	380	8	140	370	1,080
Pound nets and weirs					201	29,550	6	375
Fyke nets	7	105	11	22				
Stop nets			4	120				
Lines, hand and trot				100		650		
Eel pots					6	12		
Crab dredges					6	240		
Tongs, rakes, and hoes					52	475	101	1,010
Oyster dredges					4	180		
Shore and accessory property				100		326,234		3,500
Cash capital						83,000		400
Total		1,430		1,522		637,956		17,390

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Chesterfield.		Dinwiddie.		Elizabeth City.		Essex.	
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	6,000	$120	100,000	$3,000	1,120,000	$8,750	5,350	$164
Bluefish					6,870	1,374		
Bonito					200	40		
Butterfish					694,400	20,832		
Carp	1,000	60	3,000	180				
Catfish	1,200	72	27,600	1,862			4,200	170
Crevallé					269,800	8,094		
Croaker					4,465,600	110,824		
Eels					2,200	176		
Flounders					28,900	1,156		
Gizzard shad							1,500	60
Hickory shad					30,700	1,360	1,900	72
King whiting					4,700	470		
Menhaden					9,600	48		
Mullet					40,000	2,000		
Perch, white	100	8			7,900	378	7,300	406
Pigfish					4,880	538		
Pike or pickerel			740	138				
Pompano					200	70		
Redfish or red drum					500	5		
Scup					4,350	335		
Sea bass					1,100	92		
Shad	37,000	6,900	14,800	2,760	408,600	54,210	10,325	1,328
Sheepshead					50	6		
Spanish mackerel					5,900	885		
Spot					142,400	7,444		
Squeteagues or "sea trout"					2,076,000	104,180		
Striped bass	200	40			9,700	1,940	10,350	2,070
Sturgeon					5,250	1,050		
Sturgeon caviar					544	1,800		
Crabs, hard					2,038,900	67,759		
Clams, hard					13,600	5,100		
Oysters, market, public					157,500	11,025	180,950	18,095
Oysters, market, private					2,273,754	204,360	190,400	19,040
Oysters, seed, public					548,100	19,575		
Turtles					7,500	125		
Total	45,500	7,200	146,140	7,940	14,379,698	636,001	412,275	41,405

Items.	Fairfax.		Gloucester.		Henrico.		Isle of Wight.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing			5				2	
On vessels transporting			40				8	
In shore fisheries	77		584		60		273	
Shoresmen							71	
Total	77		629		60		354	
INVESTMENT.								
Vessels fishing, gasoline			2	$1,850			1	$700
Tonnage			12				6	
Outfit				350				50
Vessels transporting, gasoline			18	22,600			4	4,600
Tonnage			168				39	
Outfit				3,300				1,000
Vessels transporting, sail			2	1,800				
Tonnage			22					
Outfit				245				
Boats, sail, row, etc	50	$1,745	264	7,650	60	$1,500	29	675
Boats, power	18	3,525	194	54,825			145	38,050
Apparatus, vessel fisheries:								
Oyster dredges			2	50			1	30
Tongs			2	12				
Apparatus, shore fisheries:								
Haul seines	5	685					2	350
Gill nets	30	3,340	131	480	45	1,125	5,557	13,974
Pound nets and weirs			102	38,050			4	1,500
Fyke nets	353	2,405	25	1,010	20	40	80	4,200
Lines, hand and trot				595				18
Slat traps or baskets					40	600		
Eel pots							55	100

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Fairfax.		Gloucester.		Henrico.		Isle of Wight.	
INVESTMENT—continued.								
Apparatus, shore fisheries—Continued.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Tongs, rakes, and hoes			313	$2,378			188	$1,260
Oyster dredges			2	50				
Shore and accessory property		$450		3,125				15,400
Cash capital								5,000
Total		12,150		138,370		$3,265		86,917
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh			1,068,800	$13,360	675,000	$13,400	75,000	$1,870
Butterfish			48,660	1,460			300	12
Carp	11,900	$1,145			2,000	200	10,250	489
Catfish	126,085	7,325	1,775	89	11,600	536	10,700	370
Crevallé			171,600	5,148			200	8
Croaker			1,981,300	59,439			141,060	4,231
Eels	12,390	815					11,550	1,045
Flounders			11,461	457			5,400	324
Gizzard shad							13,400	268
Hickory shad					36,000	1,440		
Mullet			2,750	138			1,800	180
Perch, white	8,950	915	1,381	75	12,000	960	12,429	1,242
Perch, yellow	16,060	1,385						
Pigfish			30	5				
Pike or pickerel	275	55						
Shad	93,705	19,150	241,294	31,568			222,224	41,325
Spanish mackerel			10	1				
Spot			29,295	1,450			600	48
Squeteagues or "sea trout"			1,324,990	66,250			38,250	3,330
Striped bass	3,625	725	16,950	3,156			14,880	2,976
Sturgeon			1,650	330				
Sturgeon caviar			295	738				
Crabs, hard			962,666	25,980			6,250	200
Clams, hard			4,928	1,944				
Oysters, market, public			240,590	25,634			525,000	33,750
Oysters, market, private			957,579	103,973			137,585	9,827
Oysters, seed, public			14,000	500			1,183,700	42,275
Total	272,990	31,515	7,082,004	341,695	736,600	16,536	2,410,578	143,770

Items.	James City.		King George.		King and Queen.		King William.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels transporting	8		2		2		17	
In shore fisheries	68		125		139		139	
Shoresmen							135	
Total	76		127		141		291	
INVESTMENT.								
Vessels transporting, gasoline	1	$1,000	1	$800	1	$1,000	4	$11,500
Tonnage	7		19		7		45	
Outfit		200		175		200		2,100
Vessels transporting, sail	2	2,200					3	8,500
Tonnage	31						78	
Outfit		200						1,250
Boats, sail, row, etc	69	2,350	64	1,320	126	4,765	91	3,125
Boats, power	13	3,550	30	5,800	4	1,700	12	6,200
Apparatus, shore fisheries:								
Haul seines	2	600	2	550				
Gill nets	1,880	6,415	336	4,140	420	1,620	276	1,200
Pound nets and weirs	1	50	32	4,145				
Fyke nets	107	3,760	77	890	6	180	32	1,005
Lines, hand and trot				50		90		60
Eel pots	74	152					36	54
Tongs, rakes, and hoes	13	86	19	116	32	220	26	150
Oyster dredges							2	50
Shore and accessory property		2,500		950				108,300
Cash capital								31,000
Total		23,063		18,936		9,775		174,494

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	James City.		King George.		King and Queen.		King William.	
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	80,000	$3,200	155,630	$4,822			2,000	$50
Carp	21,800	1,454	5,755	258				
Catfish	61,300	4,716	37,100	2,062	6,300	$378	35,000	2,100
Croaker	2,400	195			2,400	96	11,025	441
Eels	13,650	1,099	100	8			8,000	640
Flounders	6,190	592			120	10	750	60
Gizzard shad	6,100	183						
Hickory shad			4,560	137				
Mullet	3,000	300						
Perch, white	7,900	790	23,440	2,198	120	12	350	35
Perch, yellow	200	16	8,475	660				
Pike or pickerel			4,025	780				
Shad	133,132	22,208	61,895	10,886	142,051	32,941	45,521	7,466
Squeteagues or "sea trout"	3,900	390	10,200	2,470	1,200	120	7,000	700
Striped bass	21,950	4,390	21,835	4,600	500	100	6,500	1,300
Sturgeon	2,240	580						
Sturgeon caviar	237	691						
Suckers	1,300	39						
Crabs, hard			64,375	2,060	56,250	1,350	18,750	450
Oysters, market, public			51,310	3,600	18,900	1,790		
Oysters, market, private	378,000	40,500			420,000	45,500	539,000	58,707
Total	743,299	81,343	448,700	34,541	647,841	82,297	673,896	71,949

Items.	Lancaster.		Mathews.		Middlesex.		Nansemond.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	357		9		3			
On vessels transporting	56		46		26		21	
In shore fisheries	998		1,161		1,096		137	
Shoresmen	802		61		172		30	
Total	2,213		1,277		1,297		188	
INVESTMENT.								
Vessels fishing, steam	6	$268,000						
Tonnage	702							
Outfit		68,000						
Vessels fishing, gasoline	10	217,050	2	$2,300	1	$2,000		
Tonnage	462		11		7			
Outfit		57,290		800		400		
Vessels transporting, gasoline	22	26,000	16	41,400	8	18,100	12	$15,200
Tonnage	199		165		115		117	
Outfit		6,775		11,686		2,660		2,400
Vessels transporting, sail	2	1,600	4	10,500	5	14,500		
Tonnage	25		83		115			
Outfit		75		2,300		500		
Boats, sail, row, etc	156	4,875	497	15,065	161	5,250	33	925
Boats, power	388	103,180	334	100,525	407	79,725	58	17,600
Apparatus, vessel fisheries:								
Purse seines	12	28,900						
Crab dredges			2	60				
Oyster dredges			8	350				
Tongs	6	110			2	40		
Apparatus, shore fisheries:								
Haul seines					2	100		
Gill nets			11	475			1,530	3,825
Pound nets and weirs	185	49,925	428	133,100	7	2,450		
Fyke nets	13	1,200					44	2,050
Dip nets	74	47						
Lines, hand and trot		105		1,288		321		
Tongs, rakes, and hoes	540	6,614	576	5,714	635	7,890	133	804
Oyster dredges			4	100				
Shore and accessory property		609,058		24,650		17,300		9,950
Cash capital		57,150		3,200		2,900		10,000
Total		1,505,954		353,513		154,136		62,754

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Lancaster.		Mathews.		Middlesex.		Nansemond.	
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	2,060,353	$46,580	3,057,900	$39,034	72,500	$1,900	38,225	$1,015
Alewives, salted	20,000	500						
Bluefish	2,190	438	3,556	675				
Butterfish	20,200	1,175	361,995	10,860			495	24
Carp							4,015	138
Catfish							900	45
Crevallé			74,703	2,239			495	24
Croaker	151,750	5,812	1,803,955	45,863	24,500	1,225	85,500	2,565
Eels	8,400	1,680					775	44
Flounders	6,100	445	4,780	190	450	38	5,300	318
Gizzard shad			52,570	2,103				
Hickory shad	600	24						
King whiting			260	27				
Menhaden	105,417,065	411,498						
Mullet			2,680	176				
Perch, white	4,200	420					6,000	600
Pigfish			350	53				
Scup							215	42
Shad	526,129	82,019	2,295,730	305,916	22,554	2,900	77,197	14,275
Spanish mackerel			2,479	373				
Spot	6,700	356	71,347	4,000	450	23		
Squeteagues or "sea trout"	59,150	3,113	1,375,230	68,834	34,500	3,150	5,750	288
Striped bass	33,025	6,651	9,035	1,807	400	80	9,350	1,870
Sturgeon	1,040	312	1,815	403				
Sturgeon caviar			314	948				
Crabs, hard	211,900	6,357	926,200	28,138	622,700	18,681	200	75
Crabs, soft	45,760	8,081						
Clams, hard			46,640	17,075				
Oysters, market, public	1,094,835	131,612	661,262	70,320	2,118,340	236,321	873,600	56,360
Oysters, market, private	329,238	38,878	453,432	46,695	7,350	735	398,685	28,450
Oysters, seed, public							722,750	25,813
Total	109,998,635	745,951	11,206,233	645,729	2,903,744	265,053	2,229,452	131,946

Items.	New Kent.		Norfolk.		Northampton.		Northumberland.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing			19		93		1,037	
On vessels transporting			46		43		25	
In shore fisheries	204		333		562		1,148	
Shoresmen			938		474		1,037	
Total	204		1,336		1,172		3,247	
INVESTMENT.								
Vessels fishing, steam					3	$123,750	30	$1,566,406
Tonnage					246		3,319	
Outfit						19,250		352,849
Vessels fishing, gasoline			5	$22,000			10	60,375
Tonnage			73				166	
Outfit				5,600				5,700
Vessels fishing, sail							11	6,850
Tonnage							102	
Outfit								2,760
Vessels transporting, gasoline			21	58,500	18	16,300	23	39,650
Tonnage			192		156		186	
Outfit				12,580		5,215		11,165
Vessels transporting, sail			2	3,000	2	3,400	9	33,050
Tonnage			63		25		506	
Outfit				300		775		2,995
Boats, sail, row, etc	149	$3,835	192	4,575	439	15,811	863	21,765
Boats, power	13	2,350	72	21,050	68	43,795	244	69,715
Apparatus, vessel fisheries:								
Purse seines					3	7,500	30	77,000
Crab dredges			2	75				
Oyster dredges			14	570			64	870
Apparatus, shore fisheries:								
Haul seines	5	1,100	15	8,550	10	1,675		
Gill nets	317	2,750	80	1,105	20	1,110	2	350
Pound nets and weirs	2	100	18	18,900	55	188,270	281	128,775

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	New Kent.		Norfolk.		Northampton.		Northumberland.	
INVESTMENT—contd.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Fyke nets							2	$25
Dip nets							457	152
Lines, hand and trot		$50		$540		$1,020		534
Eel pots							110	215
Eel spears					2	10		
Tongs, rakes, and hoes	2	12	149	902	292	1,191	366	2,103
Oyster dredges							54	850
Scallop dredges					106	780		
Shore and accessory property		850		744,072		298,562		1,046,779
Cash capital				215,000		40,850		169,100
Total		11,047		1,117,319		769,264		3,600,033
PRODUCTS.	*Pounds*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	260,000	$11,400	69,000	$1,380	21,000	$210	5,726,586	$77,184
Alewives, salted	10,000	400						
Black drum					500	5		
Bluefish			2,480	406	101,538	13,803	970	101
Bonito			425	65	46,915	4,675		
Butterfish			85,950	5,097	698,047	49,600	16,675	900
Carp							4,000	160
Catfish	50,000	4,000					1,100	40
Crevallé			37,900	1,650	18,250	730		
Croaker			256,000	9,625	1,632,050	75,962	688,000	7,482
Eels			50	1	1,085	250	16,870	2,358
Flounders			51,250	3,746	26,279	690	10,724	448
Hickory shad			1,600	80			20,390	883
King whiting			4,700	308	2,971	445		
Menhaden					12,025,500	23,894	207,598,310	1,463,722
Mullet			141,300	5,995	8,870	1,400		
Ocean sunfish					100	20		
Perch, white			28,350	2,460			2,455	250
Pigfish			12,010	562	7,820	298		
Pompano					1,150	240		
Redfish or red drum			2,400	48	22,800	238		
Scup					17,700	1,416		
Sea bass			4,000	400	3,500	105		
Shad	211,741	32,322	63,358	6,747	11,363	2,258	1,281,488	218,070
Sheepshead					825	126		
Spanish mackerel			250	33	4,435	665		
Spot			260,800	26,098	43,638	3,095	18,115	1,075
Squeteagues or "sea trout"			303,600	19,480	1,813,120	92,047	436,450	11,147
Striped bass	200	40	420	84	3,225	1,140	49,330	8,241
Sturgeon			5,260	1,043	47,650	6,748	500	102
Sturgeon caviar			850	2,475	1,350	4,132		
Sturgeon roe							101	150
Yellowtail or "silver perch"			2,500	75				
Crabs, hard			1,206,075	41,951	664,151	22,120	545,065	20,068
Crabs, soft					19,862	3,125	144,748	30,625
Clams, hard			4,872	2,085	72,472	21,508		
Oysters, market, public			735,000	57,750	214,550	17,808	566,972	55,850
Oysters, market, private	9,100	1,000	1,057,581	95,911	1,457,631	123,076	412,510	46,540
Oysters, seed, public					283,500	8,100		
Scallops					12,000	5,500		
Turtles	10,000	1,000						
Frogs	480	120						
Alewife scales							10,203	1,055
Total	551,521	50,282	4,337,981	285,555	19,285,849	485,429	217,551,562	1,946,451

Items.	Princess Anne.		Prince George.		Prince William.		Richmond.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing					5		4	
On vessels transporting							12	
In shore fisheries	309		70		78		239	
Shoresmen							95	
Total	309		70		83		350	

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Princess Anne.		Prince George.		Prince William.		Richmond.	
INVESTMENT.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Vessels fishing, gasoline							2	$850
Tonnage							10	
Outfit								200
Vessels fishing, sail					1	$200		
Tonnage					6			
Outfit						125		
Vessels transporting, gasoline							6	6,350
Tonnage							51	
Outfit								1,100
Boats, sail, row, etc	164	$5,610	41	$1,350	16	845	94	2,710
Boats, power	60	12,600	7	1,400	36	6,550	51	11,600
Apparatus, vessel fisheries:								
Haul seines					1	150		
Tongs							2	40
Apparatus, shore fisheries:								
Haul seines	92	13,850			3	350	1	50
Gill nets	11	330	34	2,550	37	4,085	1,403	2,874
Pound nets and weirs	5	10,200					71	8,280
Fyke nets	15	225	33	495	79	570	5	25
Lines, hand and trot		350						
Eel pots			32	64	55	190		
Tongs, rakes, and hoes	63	441					93	930
Shore and accessory property		6,090				160		12,150
Cash capital								2,300
Total		49,696		5,859		13,225		49,459
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	110,500	$1,228	66,000	$930	600	$15	36,652	$769
Black bass	342,500	44,525						
Bluefish	1,976	327						
Bonito	1,245	165						
Butterfish	56,350	3,694						
Carp	92,000	5,980	2,890	$155	10,595	$910	2,230	$110
Catfish	37,800	1,332	85,000	4,680	36,000	1,790	85,050	4,330
Crevallé	44,000	2,180						
Croaker	195,800	9,570					16,200	648
Eels	200	20	7,290	395	3,800	345	1,850	167
Flounders	23,775	1,680					2,400	192
Gizzard shad	44,150	1,523					900	45
Hickory shad	1,400	70						
King whiting	11,870	853						
Mullet	23,775	2,203						
Perch, white	435,100	27,304	6,950	695	8,550	735	12,395	1,007
Perch, yellow	30,000	1,950	780	62	7,150	565	2,700	321
Pigfish	12,250	755						
Pike or pickerel	56,000	2,900			325	65	500	100
Pompano	1,380	120						
Redfish or red drum	4,340	97						
Scup	250	25						
Shad	26,099	5,025	97,400	18,480	79,032	17,176	49,836	7,009
Sheepshead	1,250	125						
Spanish mackerel	1,980	337						
Spot	178,600	15,461						
Squeteagues or "seatrout"	70,200	7,370					2,675	134
Striped bass	6,269	209	6,500	1,300	11,800	2,250	35,200	5,530
Sturgeon	675	135						
Sturgeon caviar	150	370						
Suckers			950	29				
Yellowtail, or "silver perch"	850	51						
Crabs, hard	900,000	21,600						
Clams, hard	2,056	896						
Oysters, market, public							207,235	21,525
Oysters, market, private	87,157	35,772					150,500	19,230
Oysters, seed, private	15,925	750						
Total	2,817,872	196,602	273,760	26,726	157,852	23,851	606,323	61,117

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Spotsylvania.		Stafford.		Surry.		Warwick.	
PERSONS ENGAGED.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
On vessels fishing							3	
On vessels transporting			3					
In shore fisheries	27		122		40		232	
Shoremen	2							
Total	29		125		40		235	
INVESTMENT.								
Vessels fishing, gasoline							1	$1,200
Tonnage							5	
Outfit								150
Vessels transporting, gasoline			1	$1,000				
Tonnage			6					
Outfit				125				
Boats, sail, row, etc	24	$880	19	1,070	27	$675	96	2,850
Boats, power	10	1,550	24	3,850	13	2,650	91	25,500
Apparatus, vessel fisheries:								
Tongs							2	14
Apparatus, shore fisheries:								
Haul seines	2	250	10	4,900	3	600	1	200
Gill nets	11	1,510	19	2,135	945	2,363	415	1,037
Pound nets and weirs	15	605	10	350			39	11,400
Fyke nets	128	845	58	420	35	1,700	32	1,080
Lines, hand and trot				105		5		100
Eel pots	50	75	47	85	21	27	63	126
Tongs, rakes, and hoes							198	1,250
Shore and accessory property		4,100		1,185		15		7,150
Cash capital		100						
Total		9,915		15,225		8,035		52,057
PRODUCTS.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives, fresh	58,840	$2,200	82,840	$1,877	45,000	$450	252,400	$2,674
Bluefish							700	140
Butterfish							194,400	5,832
Carp	9,075	755	23,725	1,705	8,500	425	100	3
Catfish	62,760	3,465	56,050	3,965	18,450	967	700	34
Crevallé							135,100	4,053
Croaker					800	24	543,300	21,868
Eels	12,600	840	2,190	160	2,250	170	9,000	876
Flounders					275	17	37,530	1,505
Gizzard shad	6,050	242			14,185	284	500	15
Hickory shad			40,000	800			6,230	311
King whiting							228	23
Mullet			3,000	45				
Perch, white	15,750	1,355	5,575	600	11,795	1,415	1,100	65
Perch, yellow	17,845	1,235	7,050	602	580	58		
Pigfish							5,310	621
Pike or pickerel	9,510	1,790	3,610	778				
Shad	9,550	2,075	37,216	7,163	46,536	8,127	78,720	11,936
Spot					150	12	22,880	544
Squeteagues or "sea trout"					2,300	184	501,240	26,602
Striped bass	1,235	211	650	120	4,150	830	33,500	6,700
Sturgeon							700	140
Sturgeon caviar							57	199
Suckers					550	17		
Crabs, hard			18,335	1,600				
Oysters, market, public							526,750	37,550
Oysters, market, private							35,000	2,500
Oysters, seed, public							840,000	30,000
Turtles					400	1		
Total	203,215	14,168	280,241	19,415	155,921	12,981	3,225,445	154,191

Items.	Westmoreland.		York.		Total.	
PERSONS ENGAGED.	Number.	Value.	Number.	Value.	Number.	Value.
On vessels fishing	89		54		1,995	
On vessels transporting	23		40		563	
In shore fisheries	385		443		11,612	
Shoremen	29		36		5,208	
Total	526		573		19,378	

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Westmoreland.		York.		Total.	
INVESTMENT.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Vessels fishing, steam					45	$2,232,025
Tonnage					4,718	
Outfit						486,561
Vessels fishing, gasoline	2	$1,650	20	$57,400	81	456,975
Tonnage	14		140		1,150	
Outfit		550		12,040		108,523
Vessels fishing, sail	17	10,675			44	29,350
Tonnage	130				354	
Outfit		4,340				14,572
Vessels transporting, gasoline	2	4,800	15	24,100	222	375,450
Tonnage	45		135		2,125	
Outfit		725		3,505		80,752
Vessels transporting, sail	6	15,900	4	7,000	56	128,900
Tonnage	142		86		1,536	
Outfit		970		350		13,660
Boats, sail, row, etc	201	6,010	159	4,635	5,476	194,136
Boats, power	98	24,220	145	53,200	3,404	994,000
Apparatus, vessel fisheries:						
Purse seines					50	121,800
Haul seines					1	150
Crab scrapes					24	172
Crab dredges			32	1,175	62	2,450
Oyster dredges	44	585			201	4,470
Tongs			8	60	22	276
Apparatus, shore fisheries:						
Haul seines	14	4,600	5	1,000	196	41,505
Gill nets	147	560	33	1,385	15,152	98,108
Pound nets and weirs	43	5,825	65	18,350	1,882	895,762
Fyke nets	26	255	23	460	1,301	24,092
Dip nets	6	2			867	560
Stop nets					4	120
Otter trawls					1	125
Lines, hand and trot		251		1,020		8,847
Slat traps or baskets					40	600
Eel pots					562	1,132
Eel spears					2	10
Crab scrapes					531	3,784
Crab dredges			12	360	56	1,056
Crab traps					13	18
Tongs, rakes, and hoes	201	1,263	323	2,024	5,421	45,000
Oyster dredges	39	555	2	50	217	3,610
Scallop dredges					304	2,244
Shore and accessory property		3,870		13,082		3,561,449
Cash capital		1,400		5,750		777,255
Total		89,006		206,946		10,709,499
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	133,000	$2,525	296,400	$3,705	16,635,100	$258,358
Alewives, salted					30,000	900
Black bass					342,500	44,525
Black drum					59,980	792
Bluefish			600	110	178,475	27,211
Bonito					183,535	13,358
Butterfish			76,100	2,283	3,018,842	136,894
Carp	42,085	4,238			282,695	20,559
Catfish	30,815	1,547			826,485	48,383
Crevallé			8,400	252	760,448	24,378
Croaker	2,825	65	1,552,924	53,301	16,372,134	513,975
Eels					121,800	12,559
Flounders			31,190	1,278	313,584	15,715
Gizzard shad					[redacted]	[redacted]
Goldfish					4,050	380
Hickory shad	100	5	11,850	474	[redacted]	[redacted]
King whiting			50	5	40,222	3,411
Mackerel			260	23	70,677	8,473
Menhaden			48,000	240	366,379,425	2,158,518
Mullet			6,000	240	458,158	17,417
Ocean sunfish					100	20
Perch, white	16,560	1,717	3,100	181	648,165	46,638
Perch, yellow	24,265	3,468			117,755	10,547
Pigfish			1,050	91	69,300	3,523
Pike or pickerel	5,875	1,475			80,860	8,081
Pompano					6,930	1,430
Redfish or red drum					117,550	3,753
Scup					35,140	2,418
Sea bass					18,975	1,427

56,785 2,620 8,150

216,520

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF VIRGINIA IN 1920, BY COUNTIES—Continued.

Items.	Westmoreland.		York.		Total	
PRODUCTS—continued.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Shad	24,078	$4,767	134,100	$17,88	7,293,805	$1,145,106
Sheepshead					2,155	263
Spanish mackerel			155	25	33,839	5,039
Spot			55,800	3,721	967,296	67,270
Squeteagues or "sea trout"	17,400	1,055	584,250	33,482	12,908,502	654,521
Striped bass	45,355	8,058	5,100	1,020	379,568	68,858
Sturgeon			1,029	206	78,388	14,368
Sturgeon caviar					5,172	16,038
Sturgeon roe					101	150
Suckers					2,800	85
Yellowtail or "silver perch"					3,350	126
Crabs, hard	255,000	7,655	3,192,050	102,635	12,465,342	401,295
Crabs, soft	560	150	16,000	1,600	1,171,737	164,269
Squid					42,150	1,475
Clams, hard			29,696	11,140	499,440	229,645
Oysters, market, public	1,016,351	23,454	441,700	29,120	10,757,488	993,548
Oysters, market, private	71,050	3,875	458,871	46,686	11,823,420	1,174,375
Oysters, seed, public			1,202,600	42,950	5,008,150	178,038
Oysters, seed, private					155,925	3,200
Scallops					113,760	26,852
Terrapin					248	360
Turtles					18,680	1,165
Frogs					480	120
Cabomba					900	90
Alewife scales					10,203	1,055
Total	1,685,319	114,051	8,157,275	352,648	471,219,089	8,541,724

FISHERIES BY APPARATUS.

The yield of the vessel fisheries of Virginia in 1920 was 366,805,629 pounds, valued at $2,634,383, consisting chiefly of menhaden taken with purse seines, 360,145,505 pounds, valued at $2,136,404; oysters, taken with dredges and tongs, 4,229,694 pounds, or 604,242 bushels, valued at $384,469; crabs, with dredges and scrapes, 2,408,630 pounds, valued at $110,810, of which 2,368,250 pounds, valued at $105,965, are credited to dredges. In the shore fisheries the most productive form of apparatus is the pound net, the catch amounting to 59,554,037 pounds, valued at $2,448,853. The species taken in the largest quantities with pound nets were alewives, croakers, squeteagues, menhaden, shad, and butterfish. Tongs, rakes, and hoes, used chiefly in the taking of oysters, yielded 20,343,099 pounds, valued at $1,897,186. The catch with lines, consisting principally of hard crabs, amounted to 10,591,468 pounds, valued at $345,842; with gill nets, 3,445,035 pounds, valued at $389,820, the principal species being shad, croaker, alewives, and mullet; with seines, 2,838,227 pounds, valued at $202,039, principally alewives, white perch, black bass, croaker, and squeteagues. Of the total catch of crabs taken with dredges, amounting to 3,068,800 pounds, valued at $136,341, 700,550 pounds, valued at $30,376, were credited to the shore fisheries. Of the total catch of crabs with scrapes, amounting to 855,262 pounds, valued at $105,807, 814,882 pounds, valued at $100,962, are credited to the shore fisheries.

The products of the vessel and shore fisheries are shown separately in the appended tables.

YIELD OF THE VESSEL FISHERIES OF VIRGINIA IN 1920, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Accomac.		Elizabeth City.		Gloucester.		Isle of Wight.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Purse seines: Menhaden	37,218,600	$245,283						
Crab dredges: Crabs, hard			938,775	$41,824				
Oyster dredges:								
Oysters, market, public	288,022	27,748						
Oysters, market, private	168,000	18,000	2,082,535	190,701	21,000	$3,000	4,900	$350
Total	456,022	45,748	2,082,535	190,701	21,000	3,000	4,900	350
Tongs:								
Oysters, market, public					2,100	150		
Oysters, seed, public					14,000	500		
Total					16,100	650		
Scrapes: Crabs, soft	40,380	4,845						
Grand total	37,715,002	295,876	3,021,310	232,525	37,100	3,650	4,900	350

Apparatus and species.	Lancaster.		Mathews.		Middlesex.		Norfolk.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Purse seines: Menhaden	104,989,565	$409,533						
Crab dredges: Crabs, hard			17,600	$880			261,075	$11,711
Oyster dredges:								
Oysters, market, private			45,500	4,875			812,000	69,600
Tongs:								
Oysters, market, public	5,600	720			56,000	$6,400		
Oysters, market, private	66,500	7,100						
Total	72,100	7,820			56,000	6,400		
Grand total	105,061,665	417,353	63,100	5,755	56,000	6,400	1,073,075	81,311

Apparatus and species.	Northampton.		Northumberland.		Prince William.		Richmond.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Purse seines: Menhaden	11,400,000	$22,800	206,537,340	$1,458,788				
Haul seines:								
Carp					1,350	$150		
Catfish					8,000	400		
Perch, white					1,200	100		
Perch, yellow					1,250	100		
Striped bass					10,000	1,950		
Total					21,800	2,700		
Oyster dredges: Oysters, market, public			206,472	21,265				
Tongs: Oysters, market, public							24,500	$2,800
Grand total	11,400,000	22,800	206,743,812	1,480,053	21,800	2,700	24,500	2,800

YIELD OF THE VESSEL FISHERIES OF VIRGINIA IN 1920, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Purse seines: Menhaden							360,145,505	$2,136,404
Haul seines:								
Carp							1,350	150
Catfish							8,000	400
Perch, white							1,200	100
Perch, yellow							1,250	100
Striped bass							10,000	1,950
Total							21,800	2,700
Crab dredges: Crabs, hard					1,150,800	$51,550	2,368,250	105,965
Oyster dredges:								
Oysters, market, public			376,565	$27,540			871,059	76,553
Oysters, market, private							3,133,935	286,526
Total			376,565	27,540			4,004,994	363,079
Tongs:								
Oysters, market, public	14,000	$900			29,400	2,370	131,600	13,340
Oysters, market, private							66,500	7,100
Oysters, seed, public					12,600	450	26,600	950
Total	14,000	900			42,000	2,820	224,700	21,390
Scrapes: Crabs, soft							40,380	4,845
Grand total	14,000	900	376,565	27,540	1,192,800	54,370	366,805,629	2,634,383

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES.

BY SEINES.

Species.	Accomac.		Arlington.		Charles City.		Dinwiddie.		Essex.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh					100,000	$1,500	40,000	$1,200	1,500	$60
Carp			1,650	$150			1,000	60		
Catfish			5,800	285			2,000	120	1,800	90
Croaker	24,724	$955								
Flounders	2,820	190								
Goldfish			2,050	180						
Hickory shad									1,500	60
King whiting	800	120								
Mullet	2,813	225	1,570	160						
Perch, white			850	80					3,600	36
Perch, yellow			1,550	120						
Pigfish	9,600	120								
Shad					6,200	1,260	740	138	1,050	135
Spot	4,605	315								
Squeteagues or "sea trout"	14,898	1,100								
Striped bass			140	35					3,000	600
Total	60,260	3,025	13,610	1,010	106,200	2,760	43,740	1,518	12,450	981

Species.	Fairfax.		Isle of Wight.		James City.		King George.		New Kent.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh					20,000	$800			170,000	$7,800
Alewives, salted									10,000	400
Carp	8,550	$810	6,000	$360	3,800	228	300	$25		
Catfish	13,965	865	1,500	90	7,700	460	4,000	225		
Croakers			1,000	30						
Gizzard shad					5,600	168				
Perch, white	750	75			2,200	220	2,500	150		

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY SEINES—Continued.

Species.	Fairfax.		Isle of Wight.		James City.		King George.		New Kent.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Perch, yellow	3,200	$300					700	$60		
Pike or pickerel	125	25					250	50		
Shad					8,125	$1,150			28,570	$3,836
Striped bass	3,625	725	1,500	$300	5,500	1,100	9,800	2,450	200	40
Suckers					1,200	36				
Total	30,215	2,800	10,000	780	54,125	4,162	17,550	2,960	208,770	12,076

Species.	Norfolk.		Northampton.		Princess Anne.		Prince William.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh					100,000	$1,000		
Black bass					340,000	44,200		
Bluefish	1,180	$236	775	$78				
Butterfish	5,350	321						
Carp					90,000	5,850	7,800	$650
Catfish					36,000	1,260	6,000	300
Croaker	116,000	3,705	26,355	1,240				
Flounders	19,000	830	3,209	200				
Gizzard shad					36,000	1,260		
King whiting	2,200	118	1,305	195	500	50		
Mullet	24,300	2,195			3,500	280		
Perch, white	20,750	2,040			422,000	26,340	200	20
Perch, yellow					18,000	1,170	250	20
Pigfish	5,010	238	1,470	125				
Pike or pickerel					45,000	2,430	125	25
Spot	164,100	16,370	5,870	515	5,000	700		
Squeteagues or "sea trout"	125,600	8,590	87,885	4,910	1,500	150		
Striped bass			600	90	1,400	235	1,800	300
Yellowtail or "silver perch"	2,000	60						
Total	485,490	34,703	127,469	7,353	1,098,900	84,925	16,175	1,315

Species.	Richmond.		Spotsylvania.		Stafford.		Surry.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh					42,440	$767		
Carp	400	$20	9,000	$750	20,600	1,555	2,200	$110
Catfish	150	9	2,200	110	44,600	3,395	9,400	470
Eels			75	5				
Gizzard shad							8,000	160
Hickory shad					40,000	800		
Mullet					3,000	45		
Perch, white			1,175	100	3,425	330	7,425	891
Perch, yellow			1,550	110	1,150	90	250	25
Pike or pickerel			2,750	550	570	120		
Shad					4,108	613	1,050	180
Squeteagues or "sea trout"							500	40
Striped bass			100	20	650	120	2,750	550
Suckers							400	12
Total	550	29	16,850	1,645	160,543	7,835	31,975	2,438

Species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh							473,940	$13,127
Alewives, salted							10,000	400
Black bass							340,000	44,200
Bluefish					500	$90	2,455	404
Butterfish							5,350	321
Carp			41,650	$4,200			192,950	14,768
Catfish			14,100	687			149,215	8,366
Croaker	3,000	$240			149,200	7,140	320,279	13,310
Eels							75	5
Flounders					350	14	25,379	1,234
Gizzard shad							49,600	1,588
Goldfish							2,050	180
Hickory shad							41,500	860
King whiting					260	23	5,065	506

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY SEINES—Continued.

Species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Mullet							35,183	$2,905
Perch, white			6,260	$772	350	$18	471,485	31,072
Perch, yellow			18,540	3,070			45,190	4,965
Pigfish					350	32	16,430	515
Pike or pickerel			5,375	1,375			54,195	4,575
Shad							49,843	7,312
Spanish mackerel					55	10	55	10
Spot					19,000	1,330	198,575	19,230
Squeteagues or "sea trout"	2,500	$200			55,000	5,500	287,883	20,490
Striped bass	1,200	240	21,465	3,943	4,200	840	57,930	11,588
Suckers							1,600	48
Yellowtail or "silver perch"							2,000	60
Total	6,700	680	107,390	14,047	229,265	14,997	2,838,227	202,039

BY GILL NETS.

Species.	Accomac.		Arlington.		Caroline.		Charles City.		Chesterfield.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives					4,500	$90				
Bluefish	820	$205								
Carp					180	9				
Croaker	194,000	6,520								
Hickory shad					4,500	180				
King whiting	4,643	325								
Mackerel	70,417	8,450								
Mullet	220,350	4,330								
Perch, white					1,200	120				
Shad			80,282	$15,288	6,737	867	300,300	$55,510	37,000	$6,900
Spot	22,000	550								
Squeteagues or "sea trout"	10,937	625								
Striped bass					500	100				
Sturgeon	330	100								
Sturgeon caviar	38	125								
Total	523,535	21,230	80,282	15,288	17,617	1,366	300,300	55,510	37,000	6,900

Species.	Dinwiddie.		Elizabeth City.		Essex.		Fairfax.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives	60,000	$1,800			900	$36		
Mullet			40,000	$2,000				
Perch, white					2,200	220		
Shad	14,800	2,760			8,575	1,103	93,705	$19,150
Striped bass					6,650	1,330		
Total	74,800	4,560	40,000	2,000	18,325	2,689	93,705	19,150

Species.	Gloucester.		Henrico.		Isle of Wight.		James City.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			300,000	$6,000				
Catfish	1,775	$89						
Croaker	15,600	468						
Hickory shad			30,000	1,200				
Mullet	2,750	138			1,800	$180	3,000	$300
Perch, white	390	20						
Shad	5,950	969			211,702	39,476	125,007	21,058
Spot	16,200	810						
Squeteagues or "sea trout"	7,650	384						
Striped bass	3,500	700						
Sturgeon							2,240	580
Sturgeon caviar							237	691
Total	53,815	3,578	330,000	7,200	213,502	39,656	130,484	22,629

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY GILL NETS—Continued.

Species.	King George.		King and Queen.		King William.		Mathews.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives	73,880	$2,552						
Bluefish							1,800	$324
Carp	4,600	184						
Catfish	1,900	95						
Croaker							55,600	2,139
Hickory shad	4,560	137						
Mullet							2,000	140
Perch, white	8,750	850						
Shad	51,860	9,048	142,051	$32,941	45,521	$7,466		
Spot							15,500	1,206
Squeteagues or "sea trout"							19,300	1,897
Striped bass	8,400	1,680					5,500	1,100
Total	153,950	14,546	142,051	32,941	45,521	7,466	99,700	6,806

Species.	Nansemond.		New Kent.		Norfolk.		Northampton.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bluefish							12,500	$500
Croaker					40,000	$1,600	2,000	200
Flounders					1,050	84		
Mullet					117,000	3,800	8,870	1,400
Perch, white					4,000	240		
Pigfish					300	9		
Shad	68,250	$12,600	183,171	$28,486	1,800	345		
Spot					40,000	4,160	3,530	300
Sturgeon							2,250	758
Sturgeon caviar							230	552
Total	68,250	12,600	183,171	28,486	204,150	10,238	29,380	3,710

Species.	Northumberland.		Prince George.		Prince William.		Princess Anne.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives					600	$15		
Carp					500	40		
Croaker	5,000	$50					3,200	$192
Mullet							10,000	1,200
Shad	1,280	270	97,400	$18,480	79,032	17,176		
Squeteagues or "sea trout"	1,200	25					1,100	110
Total	7,480	345	97,400	18,480	80,132	17,231	14,300	1,502

Species.	Richmond.		Spotsylvania.		Stafford.		Surry.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			58,840	$2,200	40,000	$1,100		
Pike or pickerel			350	70				
Shad	35,548	$4,928	9,550	2,075	33,108	6,550	35,365	$6,285
Total	35,548	4,928	68,740	4,345	73,108	7,650	35,365	6,285

Species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives							538,720	$13,793
Bluefish							15,120	1,029
Carp							5,280	233
Catfish							3,675	184
Croaker					130,724	$3,921	446,124	15,090
Flounders							1,050	84
Hickory shad							39,060	1,517
King whiting							4,643	325
Mackerel							70,417	8,450
Mullet					6,000	240	411,770	13,728
Perch, white			400	$40	2,100	105	19,040	1,595
Pigfish					650	52	950	61
Pike or pickerel							350	70

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY GILL NETS—Continued.

Species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Shad	19,500	$3,400	3,200	$700			1,690,694	$313,831
Spot					22,200	$1,555	119,430	8,581
Squeteagues or "sea trout"					8,250	412	48,437	3,453
Striped bass			400	80			24,950	4,360
Sturgeon							4,820	1,438
Sturgeon caviar							505	1,368
Total	19,500	3,400	4,000	820	169,924	6,285	3,445,035	389,820

BY POUND NETS.

Species.	Accomac.		Caroline.		Elizabeth City.		Essex.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	839,724	$12,524	6,250	$250	1,120,000	$8,750	2,950	$68
Black drum	53,980	677						
Bluefish	5,750	1,950			6,870	1,374		
Bonito	134,750	8,413			200	40		
Butterfish	765,270	35,125			694,400	20,832		
Catfish			100	5			2,400	80
Crevallé					269,800	8,094		
Croaker	2,575,325	96,464			4,420,000	109,000		
Eels	4,800	1,200			200	16		
Flounders	45,390	1,864			28,900	1,156		
Gizzard shad							1,500	60
Hickory shad	4,120	211			30,700	1,360	400	12
King whiting	7,500	635			2,300	230		
Menhaden	4,062,350	13,833			9,600	48		
Perch, white			620	49	7,900	378	1,500	150
Pigfish	16,000	480			2,380	288		
Pompano	4,200	1,000			200	70		
Redfish or red drum	79,840	3,135			500	5		
Scup	8,250	425			4,350	335		
Sea bass					1,100	92		
Shad	414,927	76,822	945	122	408,600	54,210	700	90
Sheepshead	30	6			50	6		
Spanish mackerel	18,630	2,720			5,900	885		
Spot	108,486	2,985			131,600	6,580		
Squeteagues or "sea trout"	4,198,672	207,710			2,058,000	102,900		
Striped bass	16,644	1,075			9,700	1,940	700	140
Sturgeon	10,249	3,219			5,250	1,050		
Sturgeon caviar	1,337	4,560			544	1,800		
Squid	42,150	1,475						
Turtles	780	39			7,500	125		
Total	13,419,154	478,547	7,915	426	9,226,544	321,564	10,150	600

Species.	Gloucester.		Isle of Wight.		James City.		King George.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	1,068,800	$13,360	9,500	$238	45,000	$1,800	81,750	$2,270
Butterfish	48,660	1,460	300	12				
Carp			250	9			570	29
Catfish			400	16			16,300	977
Crevallé	171,200	5,136	200	8				
Croaker	1,961,300	58,839	2,800	84				
Eels			250	25			100	8
Flounders	9,261	369						
Perch, white	456	28	300	30			8,590	845
Perch, yellow							2,200	175
Pigfish	30	5						
Pike or pickerel							25	5
Shad	235,344	30,599	2,220	396			10,035	1,838
Spanish mackerel	10	1						
Spot	10,860	544						
Squeteagues or "sea trout"	1,313,490	65,675	9,500	760			400	20
Striped bass	4,400	880	4,100	820			13,350	2,905
Sturgeon	1,650	330						
Sturgeon caviar	295	738						
Total	4,825,756	177,964	29,820	2,398	45,000	1,800	133,320	9,072

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY POUND NETS—Continued.

Species.	Lancaster.		Mathews.		Middlesex.		New Kent.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	2,060,233	$46,578	3,057,900	$39,034	72,500	$1,900	90,000	$3,600
Alewives, salted	20,000	500						
Bluefish	2,190	438	1,756	351				
Butterfish	20,200	1,175	361,995	10,860				
Crevallé			74,703	2,239				
Croaker	141,750	5,712	1,748,355	43,724	24,500	1,225		
Eels	3,000	600						
Flounders	6,100	445	4,780	190	450	38		
Hickory shad	600	24	52,570	2,103				
King whiting			260	27				
Menhaden	427,500	1,965						
Mullet			680	36				
Perch, white	1,650	165						
Pigfish			350	53				
Shad	526,054	82,006	2,295,730	305,916	22,554	2,900		
Spanish mackerel			2,479	373				
Spot	6,700	356	55,847	2,794	450	23		
Squeteagues or "sea trout"	59,000	3,083	1,355,930	66,937	34,500	3,150		
Striped bass	24,675	3,998	3,535	707	400	80		
Sturgeon	1,040	312	1,815	403				
Sturgeon caviar			314	948				
Total	3,300,692	147,357	9,018,999	476,695	155,354	9,316	90,000	3,600

Species.	Norfolk.		Northampton.		Northumberland.		Princess Anne.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	69,000	$1,380	21,000	$210	5,726,586	$77,184	8,700	$174
Black drum			500	5				
Bluefish	900	90	88,263	13,225	970	101	1,976	327
Bonito	425	65	46,915	4,675			1,245	165
Butterfish	80,600	4,776	698,047	49,600	16,675	900	56,350	3,694
Carp					4,000	160		
Catfish					1,100	40		
Crevallé	37,900	1,650	18,250	730			44,000	2,180
Croaker	52,000	1,920	1,603,695	74,522	680,500	7,407	72,600	2,178
Eels	50	1	670	200	7,495	1,118	200	20
Flounders	21,200	2,032	23,070	490	10,724	448	17,775	1,320
Gizzard shad							150	3
Hickory shad	1,600	80			20,390	883	1,400	70
King whiting	500	30	1,666	250			7,370	483
Menhaden			625,500	1,094	1,060,970	4,934		
Mullet							10,275	723
Ocean sunfish			100	20				
Perch, white					2,455	250	3,100	314
Pigfish	2,700	155	6,350	173			8,250	515
Pompano			1,150	240			1,380	120
Redfish or red drum	2,400	48	22,800	238			4,340	97
Scup			17,700	1,416			250	25
Sea bass			3,500	105				
Shad	61,558	6,402	11,363	2,258	1,280,208	217,800	26,099	5,025
Sheepshead			825	126			1,250	125
Spanish mackerel	250	33	4,435	665			1,980	337
Spot	16,700	768	34,238	2,280	18,115	1,075	83,600	5,761
Squeteagues or "sea trout"	130,000	6,090	1,725,235	87,137	435,250	11,122	55,600	4,910
Striped bass	420	84	2,625	1,050	49,330	8,241	1,669	334
Sturgeon	5,260	1,043	45,400	5,990	500	102	675	135
Sturgeon caviar	850	2,475	1,120	3,580			150	370
Sturgeon roe					101	150		
Yellowtail or "silver perch"	500	15					850	51
Alewife scales					10,203	1,055		
Total	484,813	29,137	5,004,417	250,279	9,325,572	332,970	411,234	29,456

Species.	Richmond.		Spotsylvania.		Stafford.		Warwick.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	36,652	$769					252,400	$2,674
Bluefish							700	140
Butterfish							194,400	5,832
Carp	1,730	87	75	$5	625	$50		
Catfish	79,250	4,037	22,560	1,455	2,000	100		

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY POUND NETS—Continued.

Species.	Richmond.		Spotsylvania.		Stafford.		Warwick.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Crevallé							135,100	$4,053
Croaker	16,200	$648					466,100	16,692
Eels	1,400	124	150	$10	300	$20	200	20
Flounders	2,400	192					35,730	1,429
Gizzard shad	900	45	6,050	242				
Hickory shad							6,230	311
King whiting							228	23
Perch, white	12,270	994	10,175	870	900	150		
Perch, yellow	2,575	306	4,350	300	750	100		
Pigfish							210	21
Pike or pickerel	200	40	1,635	275	1,400	280		
Shad	14,288	2,081					59,220	8,536
Spot							14,880	744
Squeteagues or "sea trout"	2,675	134					449,000	22,460
Striped bass	35,200	5,530	935	161			30,500	6,100
Sturgeon							700	140
Sturgeon caviar							57	199
Total	205,740	14,987	45,930	3,318	5,975	700	1,645,655	69,374

Species.	Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives, fresh	133,000	$2,525	296,400	$3,705	14,998,345	$218,993
Alewives, salted					20,000	500
Black drum					54,480	682
Bluefish			100	20	109,475	18,016
Bonito					183,535	13,358
Butterfish			76,100	2,283	3,012,997	136,549
Carp	435	38			7,685	378
Catfish	12,915	660			137,025	7,370
Crevallé			8,400	252	759,553	24,342
Croaker	2,825	65	861,000	25,830	14,628,950	444,310
Eels					18,815	3,362
Flounders			29,650	1,186	235,430	11,159
Gizzard shad					8,600	350
Hickory shad	100	5	11,850	474	129,960	5,533
King whiting			50	5	19,874	1,683
Menhaden			48,000	240	6,233,920	22,114
Mullet					10,955	759
Ocean sunfish					100	20
Perch, white	9,600	875	450	22	59,966	5,120
Perch, yellow	3,725	273			13,600	1,154
Pigfish			50	7	36,320	1,697
Pike or pickerel	250	50			3,510	650
Pompano					6,930	1,430
Redfish or red drum					109,880	3,523
Scup					30,550	2,201
Sea bass					4,600	197
Shad	20,878	4,067	134,100	17,880	5,524,823	818,948
Sheepshead					2,155	263
Spanish mackerel			100	15	33,784	5,029
Spot			9,000	450	490,476	24,360
Squeteagues or "sea trout"	17,400	1,055	461,000	23,050	12,305,652	606,193
Striped bass	23,490	4,035	100	20	221,773	38,100
Sturgeon			1,029	206	73,568	12,930
Sturgeon caviar					4,667	14,670
Sturgeon roe					101	150
Yellowtail or "silver perch"					1,350	66
Squid					42,150	1,475
Turtles					8,280	164
Alewife scales					10,203	1,055
Total	224,618	13,648	1,937,379	75,645	59,554,037	2,448,853

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY FYKE NETS.

Species.	Accomac.		Arlington.		Caroline.		Charles City.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives					50	$2	9,000	$180
Carp			145	$10	100	5	25,700	2,020
Catfish			10,500	510	400	20	22,200	1,688
Croaker	8,571	$300						
Flounders	2,000	100						
Goldfish			2,000	200				
Mullet			250	25				
Perch, white			475	43	250	25	5,020	498
Perch, yellow			600	55			500	50
Shad	1,740	350						
Striped bass	750	150					300	60
Total	13,061	900	13,970	843	800	52	62,720	4,496

Species.	Chesterfield.		Dinwiddie.		Fairfax.		Gloucester.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	6,000	$120						
Carp	1,000	60			3,350	$335		
Catfish	1,200	72	3,000	$180	112,120	6,460		
Crevallé							400	$12
Croaker							4,400	132
Eels					12,390	815		
Flounders							2,200	88
Perch, white	100	8			8,200	840	535	27
Perch, yellow					12,860	1,085		
Pike or pickerel					150	30		
Spot							2,235	96
Squeteagues or "sea trout"							3,850	191
Striped bass	200	40					9,050	1,576
Total	8,500	300	3,000	180	149,070	9,565	22,670	2,122

Species.	Henrico.		Isle of Wight.		James City.		King and Queen.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			65,500	$1,632	15,000	$600		
Carp			4,000	120	18,000	1,226		
Catfish	3,600	$216	8,800	264	53,600	4,256	6,300	$378
Croaker			132,760	3,982	2,400	195	2,400	96
Eels			2,300	220	1,150	99		
Flounders			5,400	324	6,190	592	120	10
Gizzard shad			13,400	268	500	15		
Perch, white			12,129	1,212	5,700	570	120	12
Perch, yellow					200	16		
Shad			8,302	1,453				
Spot			600	48				
Squeteagues or "sea trout"			26,750	2,410	3,900	390	1,200	120
Striped bass			9,280	1,856	16,450	3,290	500	100
Suckers					100	3		
Total	3,600	216	289,221	13,789	123,190	11,252	10,640	716

Species.	King George.		King William.		Lancaster.		Nansemond.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			2,000	$50	120	$2	38,225	$1,015
Butterfish							495	24
Carp	285	$20					4,015	138
Catfish	14,900	765	31,500	1,890			900	45
Crevallé							495	24
Croaker			11,025	441	10,000	100	85,500	2,565
Eels					5,400	1,080	775	44
Flounders			750	60			5,300	318
Perch, white	3,600	353	350	35	2,550	255	6,000	600
Perch, yellow	5,575	425						
Pike or pickerel	3,750	725						
Scup							215	42
Shad					75	13	8,947	1,675
Squeteagues or "sea trout"			7,000	700	150	30	5,750	288
Striped bass	85	15	3,500	700	8,350	2,653	9,350	1,870
Total	28,195	2,303	56,125	3,876	26,645	4,133	165,967	8,648

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY FYKE NETS—Continued.

Species.	Northumberland.		Princess Anne.		Prince George.		Prince William.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives			1 800	$54	66,000	$930		
Black bass			2 500	325				
Carp			2,000	130	2,890	155	945	$70
Catfish			1,800	72	85,000	4,680	22,000	1,090
Croaker	2,500	$25						
Eels					1,790	95	675	45
Gizzard shad			8,000	260				
Perch, white			10,000	650	6,950	695	7,150	615
Perch, yellow			12,000	780	780	62	5,650	445
Pike or pickerel			11,000	470			200	40
Striped bass					6,500	1,300		
Suckers					950	29		
Total	2,500	25	49,100	2,741	170,860	7,946	36,620	2,305

Species.	Richmond.		Spotsylvania.		Stafford.		Surry.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives					400	$10	45,000	$450
Carp	100	$3			2,500	100	6,300	315
Catfish	5,650	284	38,000	$1,900	9,450	470	4,550	227
Croaker							800	24
Eels	450	43	375	25	140	10	250	10
Flounders							275	17
Gizzard shad							6,185	124
Perch, white	125	13	4,400	385	1,250	120	4,370	524
Perch, yellow	125	15	11,945	825	5,150	412	330	33
Pike or pickerel	300	60	4,775	895	1,640	378		
Shad							10,121	1,662
Spot							150	12
Squeteagues or "sea trout"							1,800	144
Striped bass			200	30			900	180
Suckers							150	5
Turtles							400	1
Total	6,750	418	59,695	4,060	20,530	1,500	81,581	3,728

Species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Alewives							249,095	$5,045
Black bass							2,500	325
Butterfish							495	24
Carp	100	$3					71,430	4,710
Catfish	700	34	3,800	$200			439,970	25,701
Crevallé							895	36
Croaker	24,200	936			12,000	$410	296,556	9,206
Eels							25,695	2,486
Flounders	1,800	76			1,190	78	25,225	1,663
Gizzard shad	500	15					28,585	682
Goldfish							2,000	200
Mullet							250	25
Perch, white	1,100	65	300	30	200	36	80,874	7,611
Perch, yellow			2,000	125			57,715	4,328
Pike or pickerel			250	50			22,065	2,648
Scup							215	42
Shad							29,185	5,153
Spot					600	36	3,585	192
Squeteagues or "sea trout"	1,740	102			10,000	520	62,140	4,895
Striped bass	1,800	360			800	160	68,015	14,340
Suckers							1,200	37
Turtles							400	1
Total	31,940	1,591	6,350	405	24,790	1,240	1,468,090	89,350

Yield of the Shore Fisheries of Virginia in 1920, by Apparatus, Counties, and Species—Continued.

BY LINES.

Species.	Accomac.		Dinwiddie.		Elizabeth City.		Gloucester.		Isle of Wight.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black drum	5,500	$110								
Bluefish	51,025	7,682								
Catfish			20,600	$1,442						
Croaker	3,375	150			45,600	$1,824			4,500	$135
Flounders	4,250	165								
King whiting	2,500	200			2,400	240				
Pigfish					2,500	250				
Redfish or red drum	7,670	230								
Scup	4,375	175								
Sea bass	10,375	830								
Spot	1,430	93			10,800	864				
Squeteagues or "sea trout"	16,590	760			18,000	1,280			2,000	160
Crabs, hard	499,636	22,173			975,000	19,200	962,666	$25,980	6,250	200
Total	606,726	32,568	20,600	1,442	1,054,300	23,658	962,666	25,980	12,750	495

Species.	King and Queen.		King George.		King William.		Lancaster.		Mathews.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Catfish					3,500	$210				
Striped bass					3,000	600				
Crabs, hard	56,250	$1,350	64,375	$2,060	18,750	450	211,900	$6,357	908,600	$27,258
Total	56,250	1,350	64,375	2,060	25,250	1,260	211,900	6,357	908,600	27,258

Species.	Middlesex.		New Kent.		Norfolk.		Northampton.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bluefish					400	$80		
Catfish			50,000	$4,000				
Croaker					48,000	2,400		
Flounders					10,000	800		
King Whiting					2,000	160		
Perch, white					3,600	180		
Pigfish					4,000	160		
Sea bass					4,000	400		
Spot					40,000	4,800		
Squeteagues or "sea trout"					48,000	4,800		
Crabs, hard	622,700	$18,681			945,000	30,240	664,151	$22,120
Turtles			10,000	1,000				
Total	622,700	18,681	60,000	5,000	1,105,000	44,020	664,151	22,120

Species.	Northumberland.		Princess Anne.		Stafford.		Surry.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Catfish							4,500	$270
Croaker			120,000	$7,200				
Flounders			6,000	360				
King whiting			4,000	320				
Pigfish			4,000	240				
Spot			90,000	9,000				
Squeteagues or "sea trout"			12,000	1,200				
Striped bass			3,200	640			500	100
Crabs, hard	545,065	$20,068	900,000	21,600	18,335	$1,600		
Total	545,065	20,068	1,139,200	40,560	18,335	1,600	5,000	370

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY LINES—Continued.

Species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black drum							5,500	$110
Bluefish							51,425	7,762
Catfish							78,600	5,922
Croaker	50,000	$4,000			400,000	$16,000	671,475	31,709
Flounders							20,250	1,325
King whiting							10,900	920
Perch, white							3,600	180
Pigfish	5,100	600					15,600	1,250
Redfish or red drum							7,670	230
Scup							4,375	175
Sea bass							14,375	1,230
Spot	8,000	800			5,000	350	155,230	15,907
Squeteagues or "sea trout"	48,000	3,840			50,000	4,000	194,590	16,040
Striped bass							6,700	1,340
Crabs, hard			255,000	$7,655	1,687,500	33,750	9,341,178	260,742
Turtles							10,000	1,000
Total	111,100	9,240	255,000	7,655	2,142,500	54,100	10,591,468	345,842

BY CRAB SCRAPES, CRAB DREDGES, OYSTER DREDGES, TONGS, RAKES AND HOES, AND HAND.

Apparatus and species.	Accomac.		Arlington.		Elizabeth City.		Essex.	
Crab scrapes:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Crabs, hard	36,560	$2,742						
Crabs, soft	778,322	98,220						
Total	814,882	100,962						
Crab dredges: Crabs, hard	221,675	6,306			125,125	$6,735		
Oyster dredges:								
Oysters, market, public	149,345	13,820						
Oysters, market, private	139,370	12,587			121,569	8,684		
Scallops	101,760	21,352						
Total	390,475	47,759			121,569	8,684		
Tongs, rakes, and hoes:								
Oysters, market, public	502,446	57,690			157,500	11,025	180,950	$18,095
Oysters, market, private	942,613	99,382			69,650	4,975	190,400	19,040
Oysters, seed, public	168,000	7,200			548,100	19,575		
Oysters, seed, private	122,500	2,138						
Clams, hard	297,000	152,710			13,200	4,950		
Total	2,032,559	319,120			788,450	40,525	371,350	37,135
Hand:								
Oysters, market, public	186,830	12,726						
Oysters, market, private	749,014	73,151						
Oysters, seed, public	45,500	1,625						
Oysters, seed, private	17,500	312						
Clams, hard	28,176	17,187			400	150		
Crabs, soft	2,100	575						
Terrapin	248	360						
Cabomba			900	$90				
Total	1,029,368	105,936	900	90	400	150		

Apparatus and species.	Gloucester.		Isle of Wight.		James City.		King and Queen.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oyster dredges: Oysters, market, private	59,500	$5,100						
Tongs, rakes, and hoes:								
Oysters, market, public	238,490	25,484	525,000	$33,750			18,900	$1,790
Oysters, market, private	877,079	95,873	132,685	9,477	378,000	$40,500	420,000	45,500
Oysters, seed, public			1,183,700	42,275				
Clams, hard	4,928	1,944						
Total	1,120,497	123,301	1,841,385	85,502	378,000	40,500	438,900	47,290

YIELD, OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY CRAB SCRAPES, CRAB DREDGES, OYSTER DREDGES, TONGS, RAKES AND HOES, AND HAND—Continued.

Apparatus and species.	King George.		King William.		Lancaster.		Mathews.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oyster dredges:								
Oysters, market, public							700	$75
Oysters, market, private			91,000	$10,400			30,100	3,225
Clams, hard							2,000	625
Total			91,000	10,400			32,800	3,925
Tongs, rakes, and hoes:								
Oysters, market, public	51,310	$3,600			1,089,235	$130,892	660,562	70,245
Oysters, market, private			448,000	48,307	262,738	31,778	377,832	38,595
Clams, hard							44,640	16,450
Total	51,310	3,600	448,000	48,307	1,351,973	162,670	1,083,034	125,290

Apparatus and species.	Middlesex.		Nansemond.		New Kent.		Norfolk.	
	Pounds	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Tongs, rakes, and hoes:								
Oysters, market, public	2,062,340	$229,921	873,600	$56,360			735,000	$57,750
Oysters, market, private	7,350	735	398,685	28,450	9,100	$1,000	245,581	26,311
Oysters, seed, public			722,750	25,813				
Clams, hard			200	75			[1] 4,872	2,085
Total	2,069,690	230,656	1,995,235	110,698	9,100	1,000	985,453	86,146
Hand: Frogs					480	120		

Apparatus and species.	Northampton.		Northumberland.		Princess Anne.		Richmond.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oyster dredges:								
Oysters, market, public			127,960	$12,490				
Oysters, market, private			49,700	5,925				
Scallops	12,000	$5,500						
Total	12,000	5,500	177,660	18,415				
Tongs, rakes, and hoes:								
Oysters, market, public	93,450	9,198	232,540	22,095			182,735	$18,725
Oysters, market, private	256,781	42,828	362,810	40,615	87,157	$35,772	150,500	19,230
Oysters, seed, private					15,925	750		
Clams, hard	68,712	20,176			[2] 2,056	896		
Total	418,943	72,202	595,350	62,710	105,138	37,418	333,235	37,955
Hand:								
Oysters, market, public	121,100	8,610						
Oysters, market, private	1,200,850	80,248						
Oysters, seed, public	283,500	8,100						
Clams, hard	3,760	1,332						
Crabs, soft	19,862	3,125						
Total	1,629,072	101,415						

Apparatus and species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Crab scrapes:								
Crabs, hard							36,560	$2,742
Crabs, soft							778,322	98,220
Total							814,882	100,962
Crab dredges: Crabs, hard					353,750	$17,335	700,550	30,376
Oyster dredges:								
Oysters, market, public			186,956	$13,554			464,961	39,939
Oysters, market, private			28,000	1,400	49,000	4,900	568,239	52,221

[1] Includes 1,800 pounds (225 bushels) from private beds, valued at $1,125.
[2] Includes 1,056 pounds (132 bushels) from private beds, valued at $396.

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY CRAB SCRAPES, CRAB DREDGES, OYSTER DREDGES, TONGS, RAKES AND HOES, AND HAND—Continued.

Apparatus and species.	Warwick.		Westmoreland.		York.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oyster dredges—Contd.								
Clams, hard							2,000	$625
Scallops							113,760	26,852
Total			214,956	$14,954	49,000	$4,900	1,148,960	119,636
Tongs, rakes, and hoes:								
Oysters, market, public	512,750	$35,650	452,830	32,360	412,300	26,750	8,987,538	842,180
Oysters, market, private	35,000	2,500	43,050	2,475	409,871	41,786	6,099,282	674,329
Oysters, seed, public	840,000	30,000			1,190,000	42,500	4,652,550	167,363
Oysters, seed, private							138,425	2,888
Clams, hard					29,696	11,140	465,304	210,426
Total	1,387,750	68,150	495,880	34,835	2,041,867	122,176	20,343,099	1,897,186
Hand:								
Oysters, market, public							307,930	21,336
Oysters, market, private							1,949,864	153,399
Oysters, seed, public							329,000	9,725
Oysters, seed, private							17,500	312
Clams, hard							32,336	18,669
Crabs, soft					16,000	1,600	37,962	5,300
Terrapin							248	360
Frogs							480	120
Cabomba							900	90
Total					16,000	1,600	2,676,220	209,311

BY OTTER TRAWLS, STOP NETS, SLAT TRAPS, AND DIP NETS.

Apparatus and species.	Accomac.		Dinwiddie.		Henrico.		Lancaster.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Otter trawls:								
Croaker	8,750	$350						
Flounders	6,250	250						
Total	15,000	600						
Stop nets:								
Carp			2,000	$120				
Catfish			2,000	120				
Total			4,000	240				
Slat traps:								
Alewives					375,000	$7,400		
Carp					2,000	200		
Catfish					8,000	320		
Hickory shad					6,000	240		
Perch, white					12,000	960		
Total					403,000	9,120		
Dip nets:								
Crabs, hard	18,604	1,395						
Crabs, soft	112,335	15,232					45,760	$8,081
Total	130,939	16,627					45,760	8,081
Crab traps: Crabs, soft	11,670	1,816						

YIELD OF THE SHORE FISHERIES OF VIRGINIA IN 1920, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY OTTER TRAWLS, STOP NETS, SLAT TRAPS, AND DIP NETS—Continued.

Apparatus and species.	Northumberland.		Westmoreland.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Otter trawls:						
Croaker					8,750	$350
Flounders					6,250	250
Total					15,000	600
Stop nets:						
Carp					2,000	120
Catfish					2,000	120
Total					4,000	240
Slat traps:						
Alewives					375,000	7,400
Carp					2,000	200
Catfish					8,000	320
Hickory shad					6,000	240
Perch, white					12,000	960
Total					403,000	9,120
Dip nets:						
Crabs, hard					18,604	1,395
Crabs, soft	144,748	$30,625	560	$150	303,403	54,088
Total	144,748	30,625	560	150	322,007	55,483
Crab traps: Crabs, soft					11,670	1,816

BY POTS AND SPEARS.

Counties.	Eels.		Counties.	Eels.	
	Pounds.	*Value.*		*Pounds.*	*Value.*
Accomac	750	$150	Prince George	5,500	$300
Charles City	2,000	120	Prince William	3,125	300
Elizabeth City	2,000	160	Spotsylvania	12,000	800
Isle of Wight	9,000	800	Stafford	1,750	130
James City	12,500	1,000	Surry	2,000	160
King William	8,000	640	Warwick	8,800	856
Northampton	415	50			
Northumberland	9,375	1,240	Total	77,215	6,706

INDUSTRIES.

Wholesale fishery trade.—In 1920 there were 206 establishments engaged in the wholesale fishery trade of Virginia, valued at $3,387,201, using a cash or working capital to the amount of $777,255 and employing 4,931 persons, to whom $1,809,545 were paid in wages.

Menhaden industry.—In 1920 there were 18 factories operated, valued at $1,727,063, as compared with 20 factories, valued at $1,307,128 in 1912. The number of menhaden utilized was 536,-879,567, valued at $2,192,837, as compared with 511,061,050, valued at $1,065,560, in 1912. The manufactured products included 40,212 tons of dry scrap and meal, valued at $3,035,169, and 2,053,363 gallons of oil, valued at $546,198, as compared with 40,255 tons of dry scrap, valued at $1,208,321, and 1,907,083 gallons of oil, valued at $426,948 in 1912. The number of vessels operated in 1920 was 50, valued at $2,477,851, with a net tonnage of 5,229 tons, and outfits valued at $541,563.

Miscellaneous industries.—In 1920 there were canned 31,919 cases of alewife roe, valued at $139,841, and of other fishery products 5,863 cases, valued at $64,371. There were salted 5,738,703 pounds of alewives, valued at $158,795. The crushed oyster-shell industry yielded 20,075 tons of poultry grit, valued at $288,675, and 31,842 tons of lime, valued at $340,371.

The detailed statistics of the industries referred to above are shown in the appended tables.

INVESTMENT, PERSONS ENGAGED, AND WAGES PAID IN THE WHOLESALE FISHERY TRADE OF VIRGINIA, 1920, BY LOCALITIES.

Localities.	Establishments.		Number of persons engaged.	Cash capital.	Wages paid.
	Number.	Value.			
Norfolk	19	$596, 955	749	$194, 000	$484, 363
Reedville, Fairport, and Fleeton	13	830, 470	537	103, 400	338, 454
Hampton and Phoebus	14	298, 524	527	83, 000	185, 355
Portsmouth	3	130, 867	189	21, 000	73, 481
Kilmarnock, Ocran, Taft, and Whitestone	4	492, 394	203	43, 000	69, 618
Chincoteague	8	123, 186	145	38, 605	67, 306
Ditchley and Hardings	3	155, 827	136	36, 000	61, 582
Willis Wharf	6	98, 422	286	30, 050	58, 931
Morattico	4	22, 000	115	5, 100	40, 830
Urbanna and Remlik	4	14, 300	98	1, 600	34, 110
Irvington	6	63, 534	167	2, 500	33, 850
Weems	7	16, 305	137	3, 650	28, 635
Wachapreague	5	15, 650	90	12, 500	26, 242
Cape Charles, Magotha, and Oyster	5	171, 440	96	9, 400	25, 420
Accomac and Chesconnessex	4	25, 788	60	53, 150	17, 200
Sanford	3	9, 620	93	7, 700	16, 989
Tangier	12	27, 273	60	8, 890	15, 150
Walnut Point, Lake, and Lewisetta	6	20, 175	132	9, 300	14, 900
Sharps and Simonson	5	11, 500	95	2, 300	14, 192
Saxis	5	13, 227	93	11, 250	9, 625
Blackwells and Tipers	10	2, 450	52	5, 700	8, 500
Franklin City and Greenbackville	8	10, 719	42	9, 950	8, 396
Lodge Cowart and Mundy Point	3	24, 600	99	8, 000	8, 300
Sampsons Wharf and Mila	5	2, 875	32	3, 700	3, 200
Miscellaneous localities	44	209, 100	698	73, 510	164, 916
Total	206	3, 387, 201	4, 931	777, 255	1, 809, 545

THE MENHADEN INDUSTRY OF VIRGINIA IN 1920.

Items.	Number.	Value.	Items.	Number.	Value.
Factories	18	$1, 727, 063	Steam vessels, fishing	42	$2, 210, 526
Cash capital		206, 005	Tonnage	4, 673	
Wages paid factory employees		540, 082	Outfit		481, 163
Persons in factories	897		Gasoline vessels, fishing	7	263, 800
Persons on vessels	1, 542		Tonnage	536	
Menhaden utilized	536, 879, 567	2, 192, 837	Outfit		59, 300
Products:			Sail vessels, fishing	1	3, 525
Dry scrap ... tons	37, 890	2, 845, 364	Tonnage	20	
Fish meal ... do	2, 322	189, 805	Outfit		1, 100
Oil ... gallons	2, 053, 363	546, 198	Apparatus on vessels: Seines (total length, 16,480 yards)	50	121, 800

Quantity and Value of Canned and Salted Fishery Products and of Fishery By-products Manufactured in Virginia in 1920.

Items.	Number.	Value.	Items.	Number.	Value.
Canned:			By-products:		
Alewife roe—			Dry scrap..........tons..	37,890	$2,845,364
No. ½ (4 dozen to case)........cases..	10	$90	Fish meal..........do....	2,322	189,805
No. 1 (4 dozen to case).......cases..	2,150	11,610	Fish oil.........gallons..	2,053,363	546,198
No. 2 (2 dozen to case).......cases..	29,759	128,141	Crushed shells.....tons..	20,075	288,675
Other products....do....	5,863	64,371	Lime..............do....	31,842	340,371
Total...........do....	37,782	204,212	Total..................	....	4,210,413
Salted: Alewives...pounds..	5,738,703	158,795	Grand total..................	....	4,573,420

FIG. 1.—SALMON ON SPAWNING BEDS.

ALASKA FISHERY AND FUR-SEAL INDUSTRIES IN 1921.[1]

By WARD T. BOWER, *Agent, Alaska Service.*

CONTENTS.

[1] Appendix X to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. 933.

INTRODUCTION.

The bureau's work in Alaska was conducted along the usual lines in the calendar year 1921. A force of temporary stream watchmen was again made use of during the active fishing season, working under the direction of the bureau's permanent employees in the patrol of the fishing grounds for the enforcement of the laws and regulations.

An expedition was again sent into the Bristol Bay region. It did excellent work in the destruction of predatory fishes and during the regular fishing season gave attention to patrolling the fishing grounds and enforcing the laws and regulations. Three hearings were held in the year, one at Juneau and two at Seattle, following which further restrictions were imposed on commercial fishing for salmon. Marking of stream mouths was continued in certain districts but was discontinued in the southeastern district because of possible changes in regulations which would require new measurements in the season of 1922.

A number of prosecutions of violations of the fisheries laws and regulations were made, convictions being secured in most cases.

A special investigation was inaugurated at Karluk in connection with the counting of salmon ascending to the spawning grounds. It is planned to continue this for a series of years, thus furnishing reliable statistics and other data to furnish a basis for definite conclusions as to relation between escapement and runs of salmon.

Regulations for the protection of walruses and sea lions in Alaska were issued, as were also a circular, containing the laws and treaties relating to fur seals and sea otters and the regulations in effect, and a new edition of the circular containing the laws and regulations for the protection of the fisheries of Alaska.

Operations in connection with the fur-seal and blue-fox industries and the administration of the affairs of the natives on the Pribilof Islands were carried on in a manner similar to previous years. The total take of sealskins in the calendar year 1921 was 23,681, and 712 blue and 21 white fox skins were taken in the trapping season of 1921–22.

The Government employees and the necessary food, fuel, and supplies for the natives and white employees were transported chiefly on vessels of the Navy Department and the Coast Guard, although two shipments of cargo were made on commercial vessels that made special trips to the Pribilofs for the purpose.

Three sales at public auction of sealskins taken on the Pribilof Islands were held at St. Louis in 1921 by the selling agents of the department. The fox skins taken in the two preceding seasons were sold at one of the sealskin auctions.

The author of this report is greatly indebted to Edward M. Ball, assistant agent, for compilation of statistics of the fisheries and preparation of accompanying text. Acknowledgment is also made to A. H. Proctor and Edward C. Johnston for assistance in the preparation of statistics and text in regard to the fur-seal industry.

REGULATIONS FOR PROTECTION OF WALRUSES AND SEA LIONS.

Under date of April 21, 1921, the Secretary of Commerce issued a new departmental circular, No. 286, containing the laws and regulations for the protection of the walruses and sea lions of Alaska. Extracts are printed from this act and from the Alaska game law of May 11, 1908.

The regulations issued by the Secretary of Commerce in regard to walruses and sea lions are as follows:

WALRUSES.

1. The killing of walruses for their tusks or hides, or both, is prohibited as being wanton destruction within the meaning of the act of May 11, 1908.
2. The killing of walruses at their breeding places in Alaska is prohibited at all times.
3. The killing of walruses throughout the territorial limits of Alaska is prohibited from May 1, 1921, to April 30, 1923, both dates included, except by natives for food or clothing, or by miners or explorers when in need of food.

SEA LIONS.

1. The killing of sea lions on their rookeries or hauling-out grounds is prohibited at all times.
2. The killing of sea lions is prohibited from May 1, 1921, to April 30, 1923, except by natives for food or clothing, or by miners or explorers when in need of food, or by anyone in the necessary protection of property or while such animals are actually engaged in the devastation of runs of salmon. The killing of sea lions under any other circumstances than the foregoing will be deemed wanton destruction and punishable as a violation of this order.

The penalties and forfeitures imposed by law will be strictly enforced against all persons who commit acts in violation thereof or of the regulations promulgated in accordance therewith.

REGULAR EMPLOYEES, ALASKA SERVICE.

During the year 1921 the following regular employees were identified with the Alaska service of the bureau:

Regular employees identified with the Alaska service in 1921.

Name.	Position.	Headquarters or chief place of duty.
Ward T. Bower	Chief agent	Washington, D. C.
Edward M. Ball	Assistant agent	Juneau.
Harry J. Christoffers	do	Seattle.
Calvin F. Townsend	Inspector	Fairbanks.
Shirley A. Baker	Assistant agent	Cordova.
Lemuel G. Wingard	do	Koggiung.
A. H. Proctor	Superintendent	St. Paul Island.
Charles E. Crompton	Agent and caretaker	St. George Island.
Henry D. Aller	do	St. Paul Island.
Edward C. Johnston	Storekeeper	St. Paul Island. (Transferred from St. George Island.)
Henry C. Scudder	do	St. George Island. (Transferred from St. Paul Island.)
George B. Bowlby	Physician	St. Paul Island.
Wm. M. Murphy	do	St. George Island.
Henry Mygatt	Assistant to agent	St. Paul Island.
Richard Culbertson	School teacher	Do.
Lois L. Proctor	do	St. Paul Island. (Resigned Oct. 16, 1921.)
Edna C Mygatt	do	St. Paul Island. (Appointed Oct. 24, 1921.)
John M. Orchard	do	St. George Island.
Michael J. O'Connor	Warden	Ketchikan.
Fred H. Gray	do	Wrangell.
Joseph N. Braun	do	Port Moller.
William E. Baumann	do	Afognak.
Chauncey C. Combs	do	Haines. (Reinstated July 1, 1921.)
James K. Nevill	do	Wrangell.
Lawrence K. Smith	do	Seldovia. (Appointed July 1, 1921.)

Regular employees identified with the Alaska service in 1921—Continued.

Name.	Position.	Headquarters or chief place of duty.
Adolph T. Looff	Warden	Naknek. (Appointed Apr. 4, 1921.)
Arthur L. Mellick	Master power vessel Eider	Unalaska.
Edwin Hofstad	Master steamer Osprey	Wrangell. (Resigned June 30, 1921.)
Jesse L. Nevill	Master patrol vessel Auklet.	Wrangell.
George G. Naud	Master patrol vessel Murre	Juneau.
Albert K. Brown	Clerk	Washington, D. C.
Mary S. Haines	do	Do.
William P. Rasin	do	Washington, D. C. (Resigned July 26, 1921.)
Edna Bishop	do	Washington, D. C. (Transferred from division of statistics and methods Oct. 14, 1921.)
E. Elaine Bell	do	Seattle.
Gladys M. Gamlen	do	Do.

Regular employees at Government hatcheries in Alaska in 1921.

Location and name.	Position.
Afognak:	
Edwin Wentworth	Superintendent.
Harry J. Heuver	Foreman.
Fred R. Lucas	Fish-culturist. (Transferred Sept. 15, 1921, to Baker Lake, Wash.)
Thomas H. Morton	Fish-culturist. (Resigned Sept. 30, 1921.)
Alfred Nelson	Fish-culturist. (Promoted Oct. 1, 1921, from apprentice fish-culturist.)
Nicolai Boskofsky	Apprentice fish-culturist.
Ray S. Woods	Apprentice fish-culturist. (Appointed Oct. 10, 1921.)
Russell Waterbury	Apprentice fish-culturist. (Reinstatement May 27, 1921.)
Gee Wah	Cook. (Appointed Apr. 26, 1921. Resigned Sept. 25, 1921.)
William Rossing	Cook. (Appointed Nov. 4, 1921.)
McDonald Lake:	
C. H. Van Atta	Superintendent.
Calvin D. Ryan	Foreman.
Albert L. Carlton	Fish-culturist. (Transferred Mar. 1, 1921, to Baker Lake, Wash.)
George L. Savage	Fish-culturist. (Transferred Mar. 1, 1921, from apprentice fish-culturist, Clackamas, Oreg.)
Arthur P. Swanberg	Fish-culturist. (Appointed June 1, 1921, apprentice fish-culturist. Promoted July 1, 1921.)
Anton Hougen	Apprentice fish-culturist. (Resigned Nov. 30, 1921.)
Barney Sevisen	Apprentice fish-culturist. (Resigned May 31, 1921. Reinstated July 1, 1921. Resigned Nov. 8, 1921.)
Casper Udstrand	Apprentice fish-culturist. (Resigned Apr. 13, 1921.)
Frank W. Ross	Apprentice fish-culturist. (Appointed May 1, 1921.)
Melvin L. Soules	Apprentice fish-culturist. (Appointed Nov. 9, 1921.)
John P. Mobley	Cook. (Resigned June 15, 1921.)
Sadie Ross	Cook. (Appointed June 22, 1921.)

FISHERY INDUSTRIES.

As in corresponding reports for previous years, the Territory of Alaska is here considered in the three coastal geographic sections generally recognized, as follows: Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and the southern coast of Alaska Peninsula, to Unimak Pass; and western Alaska, the north shore of the Alaska Peninsula, including the Aleutian Islands and Bristol Bay and the Kuskokwim and Yukon Rivers.

Detailed reports and statistical tables dealing with the various fishery industries are presented herewith, and there are also given the important features of certain subjects which were the objects of special investigation or inquiry.

WATERS CLOSED TO COMMERCIAL FISHING.

Section 6 of the act approved June 26, 1906, for the protection and regulation of the fisheries of Alaska, is as follows:

SEC. 6. That the Secretary of Commerce may, in his discretion, set aside any streams or lakes as preserves for spawning grounds, in which fishing may be limited or entirely prohibited; and when, in his judgment, the results of fishing operations in any stream, or off the mouth thereof, indicate that the number of salmon taken is larger than the natural production of salmon in such stream, he is authorized to establish close seasons or to limit or prohibit fishing entirely for one year or more within such stream or within five hundred yards of the mouth thereof, so as to permit salmon to increase: *Provided, however*, That such power shall be exercised only after all persons interested shall be given a hearing, of which due notice must be given by publication; and where the interested parties are known to the department they shall be personally notified by a notice mailed not less than thirty days previous to such hearing. No order made under this section shall be effective before the next calendar year after same is made: *And provided further*, That such limitations and prohibitions shall not apply to those engaged in catching salmon who keep such streams fully stocked with salmon by artificial propagation.

Pursuant to the provisions of this section, action was taken in 1921 in regard to waters of southeastern Alaska and the waters from Cape Newenham north and eastward to the Canadian boundary. Under date of June 17, 1921, announcement was made of hearings to consider the desirability of changes in the regulations regarding fishing in southeastern Alaska waters. The text of the announcement was as follows:

It having been recommended that the Secretary of Commerce amend the order of December 18, 1920, limiting or prohibiting fishing in the waters of Alaska east of the longitude of Cape Spencer, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act for the protection and regulation of the fisheries of Alaska," that hearings, for the purpose of eliciting information as to what, if any, changes in the present regulations are desirable, will be held at Juneau, Alaska, on October 19, 1921, at 10 o'clock a. m., and at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 15, 1921, at 10 o'clock a. m., respectively, at which all interested persons will be heard. All persons having pertinent information are particularly invited to be present and to impart such information.

Under date of June 17, 1921, announcement was also made of a hearing to be held to determine the advisability of limiting or prohibiting fishery operations in the waters of northern Alaska from Cape Newenham north and eastward to the Canadian boundary. The text of the announcement was as follows:

It having been recommended that the Secretary of Commerce limit or prohibit fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all rivers from Cape Newenham north and eastward to the Canadian boundary, and in all lakes and other waters tributary to such streams and within 500 yards of the mouths of such streams, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of limiting or prohibiting fishery operations in the waters in question will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 17, 1921, at 10 o'clock a. m., at which time and place all interested persons will be heard. All persons having pertinent information are particularly invited to be present and to impart such information.

Incidental to and in addition to the specific purpose of the hearings as covered by the announcements, Assistant Secretary of Commerce Huston, who was present, stated that in response to request statements would be received in regard to the Copper River, Kuskokwim River, and Yukon River fisheries. Following the hearings on October 19, November 15, and November 17, the department, under date of December 30, 1921, promulgated the following order:

Hearings having been given, after due notice in accordance with law, for the purpose of determining the advisability of limiting or prohibiting fishing in certain waters in Alaska, and to amend or modify certain existing regulations, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of Alaska be, and is hereby, made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Salmon fishing is prohibited in all streams, within 500 yards of their mouths, and in their tributaries and lakes, except as hereinafter permitted.
2. Fishing is permitted at Karluk beyond the zone 100 yards outside the mouth of Karluk River where it breaks through Karluk Spit into Shelikof Strait.
3. Fishing is permitted in Ugashik River below a line extending at right angles across the Ugashik 500 yards below the mouth of King Salmon River.
4. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.
5. This order does not apply to persons taking salmon by any lawful means for local human food requirements or for use as dog feed.
6. The waters of the Afognak Reservation are covered by presidential proclamation of December 24, 1892, and the regulations promulgated by authority thereof are not modified or affected by this order but remain in full force.
7. All previous orders of the Secretary of Commerce imposing limitations or prohibitions upon fishing in the waters covered by this order are hereby superseded.
8. This order becomes effective January 1, 1922.

By the restrictions and limitations imposed by successive orders of the Department of Commerce all commercial fishing in the streams and lakes of Alaska and within a zone extending 500 yards off the mouths of all streams is now prohibited, with the exception of the Ugashik and Karluk Rivers, where, owing to peculiar geographic conditions, specified districts remain open to fishing. Limitations have been placed upon fishing by Executive order or proclamation in the following waters: Afognak Reservation, Aleutian Islands Reservation, Yes Bay and Stream, and the Annette Island Fishery Reserve.

STREAM MARKING.

The marking of the mouths of salmon streams and adjacent areas closed to commercial fishing was not resumed in southeast Alaska in 1921 for the reason that contemplated changes in the regulations during the year would extend restrictions from the 200 to the 500 yard line off the mouths of streams, thus making the regulation uniformly applicable to all salmon streams regardless of width and to all forms of fishing apparatus. This condition did not exist in other sections of Alaska.

In the central district several markers were renewed at the sloughs of the Copper River delta. Markers were also placed at the mouth of Bering River and at six streams tributary to Prince William Sound. Some markers were also placed in western Alaska.

STREAM GUARDS.

In enforcing the fisheries laws and regulations of Alaska it is obviously important to prevent, as far as possible, violations of the law as well as to detect infractions and prosecute offenders. With this object in view, the policy of stationing guards at important streams or localities was continued in 1921. Twenty men were employed as stream guards during the months of greatest activity in the fisheries, 10 of whom were detailed for duty in southeast Alaska, 6 in central, and 4 in western Alaska.

The streams thus given special attention were the Chilkoot and Chilkat Rivers, Petersburg Creek and Blind River in Wrangell Narrows, Salmon Bay, Lake Bay, Ratz Harbor and Eagle Creek, Thorne Bay, Karta Bay, Boca de Quadra, and Anan Creek, all in southeast Alaska. In central Alaska guards were placed at Abercrombie and on the delta of the Copper River, on Coghill River, Eshamy Bay, and Karluk River. In the Bristol Bay district they were stationed on the Nushagak, Egegik, Igushik, and Ugashik Rivers. The foregoing does not take into account the regular employees of the Alaska service who were engaged in law enforcement at various places in each of the districts named.

FISHERY PATROL.

The bureau maintains a small fleet of power boats in Alaska for patrol work in connection with the enforcement of the laws for the protection of the seal and salmon fisheries of the Territory. Four boats were operated in 1921. Of these the *Auklet*, *Murre*, and *Puffin* were used in southeast Alaska, while the *Tern* was engaged in work on the Yukon River. The patrol was extended by the charter of the power boat *Standard* and three one-man power boats in the southeastern district, and the *Prospector*, *Lily*, *Emma*, and *Coyote* in central Alaska. The *Swan* was held in reserve on the Yukon.

In October the War Department engineer office at Juneau used the *Auklet* and *Murre* for an inspection of active and abandoned fish traps in southeast Alaska, with particular reference to their obstruction of navigation. It was understood that orders for the removal of abandoned traps would be issued, and that all active traps occupying positions of danger to vessels should be properly lighted during the winter months.

During the year the *Auklet* cruised 6,110 miles, the *Murre* 5,433, the *Puffin* 1,633 and the *Tern* 3,300, a total of 16,476 miles.

The steamer *Osprey* was towed from Wrangell to Seattle by the *Auklet* and sold at auction for $700 on June 29. On the return voyage the *Auklet* towed the *Petrel* from Seattle to Wrangell. This latter vessel, formerly the *Cobra*, was acquired by transfer from the Navy in 1919 and will be made ready for service as soon as funds are available for the purchase of a more economically operated engine than the 350-horsepower Duesenberg motor with which it is now equipped.

Vessels of the United States Coast Guard gave considerable attention to the fisheries industry, particularly the cod fishery in the region of the Aleutian Islands, which was incidental to the seal patrol, and by the stationing of the cutter *Bothwell* in southeastern Alaska during the active fishing season. The following report has been received from the Coast Guard in connection with the patrol of the *Bothwell*:

On August 9, 1921, the Coast Guard cutter *Bothwell* completed a cruise covering the principal salmon fishing area of southeast Alaska, and interviews with representatives of the Bureau of Fisheries, cannery superintendents, and fishermen elicited the following information:

(*a*) The salmon run this season is very much below normal, less than one-third in most localities.

(*b*) There are but a limited number of canneries in operation, less than half the number that operated in normal years.

(*c*) There are but approximately one-third of the traps being operated that have been open in the past, and these few are being operated largely to hold the trap sites.

(*d*) There have been no reports of trap robberies in the past 30 days and very few reports during the present season.

(*e*) The prices being paid for salmon, and the effort on the part of the canneries to confine the pack as nearly as possible to red salmon, renders the illicit sale of fish very unprofitable, a condition that is furthered by the facts that none of the small canneries are operating and that the large ones do not purchase fish without the ownership being well authenticated.

(*f*) It seems to be the general impression that the cannery season will be completed by the latter part of August.

(*g*) Reports from purchasing agents and fishermen indicate that conditions in the deep-sea fisheries are normal.

(*h*) There have been no reports of labor disturbances in the fishing industries.

It appears that the principal disturbance in the past few years has been due to a systematic robbing of the salmon traps. These traps are, for the most part, located in distant localities and are guarded by watchmen who live on the traps. It seems reasonable to assume that the traps can not, therefore, be robbed without the knowledge of the watchmen, and in most cases it has appeared that the robberies were made with the connivance of the latter. Some cases, however, have appeared in which the watchmen were intimidated with firearms. Under the latter condition it would be necessary to apprehend the robbers in the act, as the boats are disguised and there appears to be no method of identifying fish except by experts. Under the conditions in which the watchman is a party to the crime there appears to be no solution. Trapped fish can be easily identified in contradistinction to fish caught by other methods, however, and the restriction of the purchase of trapped fish in the open market is suggested.

From a general survey of the situation and the reports so far received, it appears that there will be no need for a patrol of these waters in reference to fisheries after the month of August.

ALASKA FISHERY INTELLIGENCE SERVICE.

The triweekly dissemination of telegraphic information regarding the price of certain fresh and pickled fish to the important fishery centers of southeast and central Alaska was continued by cooperation of the Alaska Military Telegraph & Cable System. The purpose of

this service is to make available to the fishermen in the several localities the market quotations on halibut, sablefish, red rockfish, and herring in the important buying centers of Ketchikan and Seattle.

VIOLATIONS OF FISHERIES LAWS AND REGULATIONS.

Violations of the fisheries laws and regulations of Alaska in 1921 covered four classes, namely, fishing in streams or within the prohibited distance of the mouths of streams, fishing by aliens, wanton waste of salmon, and fishing during the weekly close period. Those of the first category constituted 72 per cent of the cases reported and tried. Of all cases prosecuted 55 per cent were against natives and 45 per cent against whites. Considered by districts, 82½ per cent of the offenses originated in southeast Alaska, 5 per cent in central Alaska, and 12½ per cent in western Alaska. Acquittals were made in 12½ per cent of the cases tried.

Fines, including costs of trials paid by offenders, aggregated $800, of which amount $548.30 was paid in southeast Alaska, $56.30 in central Alaska, and $195.40 in western Alaska. In addition judgments entered and satisfied in cases originated in southeast Alaska in 1919 and 1920 increased by $594.25 the amount received as fines, thus making a total of $1,394.25 paid by those convicted of unlawful fishing. A brief review of each case follows.

On September 2 Peter Vick was tried and acquitted by a jury in the United States commissioner's court at Wrangell on a charge of fishing with a gill net within 200 yards of the mouth of a salmon stream at Thoms Place, Wrangell Island, July 11.

Al Lundberg, an alien, pleaded guilty before the United States commissioner at Wrangell on September 7 to fishing at Thoms Place, Wrangell Island, on July 11, and was fined $100.

In a complaint filed before the United States commissioner at Wrangell, September 2, Charles Jones, J. E. Willard, Edward Lott, and L. F. Paul were accused of wantonly wasting salmon on July 12 near Point Warde. Three of the defendants were tried late in September and acquitted, although they admitted having thrown overboard a considerable quantity of chum salmon, defending their action on the ground that the canning company for which they were fishing would not accept chum salmon. Edward Lott was not arraigned, but the case against him was dismissed in view of the outcome of the trial of his associates.

On August 9 Arthur Nelson, Charlie Johnson, Harry Atkinson, S. Milne, and Alfred Dundas were charged in a complaint filed at Ketchikan with purse-seine fishing within 200 yards of the mouth of Ketchikan Creek on August 6. They were arraigned on August 10 in the commissioner's court at Ketchikan and pleaded guilty. A fine of $10 was paid by each man, in addition to which Milne paid the costs of the prosecution, amounting to $5.60.

On August 9 complaints were also filed before the United States commissioner at Ketchikan, accusing Henry Hanson, Joe Baranovich, Eddie Young, and Joe Lemick of purse-seine fishing within 200 yards of the mouth of Ketchikan Creek on August 1. On being brought to trial on August 10 they pleaded guilty and were fined $10 each, the costs in the case, amounting to $5.60, being paid by Baranovich, owner of the boat.

Robert Young and Julius Frank were arraigned in the commissioner's court at Ketchikan on August 16, charged with purse-seine fishing within 200 yards of the mouth of Ketchikan Creek on August 3. They pleaded guilty and were fined $15 each. The costs of $14.95 were paid by Young.

On August 15 a complaint was filed before the commissioner at Ketchikan accusing Joseph Howard, Charles Howard, and Henry Reeve of fishing with a purse seine in Carrol Inlet at 9 p. m. Sunday, August 7. When the case was called for trial, they pleaded guilty and were fined $15 each, in addition to which Joseph Howard paid the costs of the trial, amounting to $38.75.

On August 10 Marco Utropini, T. H. Voss, Antone Zorith, and Robert Scherdl were found fishing with a purse seine within 500 yards of the mouth of Naha stream near Loring. They were all brought to trial at Ketchikan before the United States commissioner, except Scherdl, the cook on the boat, whose case was dismissed for the reason that he had no part in the fishing and was not responsible for the acts of the others. Upon pleading guilty, Voss and Zorith were fined $10 each, without costs, while Utropini, master of the boat, was fined $25 and costs of $9.20.

A trap located on the shore of Prince of Wales Island approximately 1 mile south of Eagle Creek and owned by Frederickson & Clark, independent operators, was found in partial fishing order on Sunday, August 7. The apron over the tunnel was 10 feet too short and the heart walls were not opened. A complaint against Frederickson & Clark was therefore filed before the commissioner at Wrangell, accusing them of a violation of the law. On September 6 Frederickson appeared in court and pleaded guilty to an unintentional violation of the statute. He was fined $50 and costs of $9.20.

On August 15 Louis Sumner and Eli Fawcet fished with a purse seine within 200 yards of the mouth of a salmon stream emptying into Tamgas Harbor, Annette Island. They were brought before the commissioner at Ketchikan on September 10, pleaded guilty, and paid fines of $10 each without costs.

Complaints were filed in the commissioner's court at Ketchikan on September 10 accusing John Davis, Sidney Campbell, and Ernest Milton of gill-net fishing in Sockeye Creek and adjacent protected waters, Annette Island, on August 12. Upon arraignment, each man pleaded guilty and paid a fine of $5.

On August 27 Jimmie Lee and Jimmie Brown were brought before the United States Commissioner at Haines charged with gill-net fishing within the protected waters at the mouth of Chilkoot River on August 23. Both men pleaded guilty and were fined $20 each.

David Young, a native of Sitka, was indicted April 6 at Juneau for unlawfully setting a seine across the mouth of Chaik Creek, which empties into the south arm of Chaik Bay, on July 30, 1920. The case was tried April 14, and on motion of the attorney for the defendant, an instructed verdict of acquittal was returned on the ground of insufficient evidence, there being no proof that any salmon had been taken.

On March 9 the grand jury at Juneau indicted Tony Flagas and John Constantine for fishing with drift gill nets in Berners Bay, Lynn Canal, during the weekly close period on September 15, 1919. When

the case was called for trial on March 11, 1921, the defendants pleaded guilty and were fined $10 each. No costs were imposed.

Complaints were filed before the United States commissioner at Cordova accusing Al Hamilton and Paul Fischer of fishing with set gill nets in Stevens Slough, Copper River delta, on June 3. Hamilton's case was called for trial on June 24 and Fischer's on July 5. Both men pleaded guilty and were fined $28.15 each, including the costs of the prosecutions.

On July 7, J. F. Johnson and R. Brodde, employees of Peter Nelson, were found fishing with gill nets in Kvichak River at Laxes Point, 1½ miles above the line marking the river's mouth, above which fishing is unlawful. They were tried July 30 before the United States commissioner at Koggiung, convicted, and fined $38.60, the costs of the case.

On July 8, J. Malgren, H. B. Anderson, A. Erickson, and G. A. Brandt, fishermen of the Alaska Packers' Association, were unlawfully fishing in Kvichak River at Laxes Point. Complaint was sworn to before the commissioner at Koggiung, alleging a violation of the regulations. On July 30 the accused were tried, found guilty, and fined $75.20, the costs of the prosecution.

Iver Helset and Iver Iversen, fishermen of Libby, McNeill & Libby, were arraigned before the United States commissioner at Koggiung on a complaint charging them with gill-net fishing in the protected waters of Kvichak River on July 9 at a point 5 miles above the mouth of the river. They were convicted and fined $41.60, the cost of the trial.

On July 10, J. Patone and S. Siliato, fishermen of the Alaska Packers' Association, were found fishing with gill nets in Kvichak River near Laxes Point, approximately 2 miles above the mouth. They were tried at Koggiung on July 30, convicted, and fined $40.

The case against Pete Knutsen and Ole Knutsen for unlawfully fishing in Petersburg Creek in 1919 as reported in that year was finally closed on May 23, 1921, when the defendants paid the fine of $250 and costs of $56.65.

The Ward's Cove Packing Co. was indicted at Ketchikan November 26, 1920, for fishing with a trap located on Clarence Strait, 4 miles north of Dall Head, during the weekly close period on August 2. The case was tried before the district court at Ketchikan June 13 to 18, and resulted in a conviction of the company. The court imposed a fine of $100 and the cost of the trial, amounting to $187.60.

The case against the Starr-Collinson Packing Co., indicted at Ketchikan in November, 1920, for failure to open the heart walls of its trap on Prince of Wales Island during the weekly close period, August 1, 1920, has not been tried.

Other cases pending are against the Kenai Packing Co. for the wanton waste of salmon and against the Copper River Packing Co. for the wanton waste of salmon and for not opening the heart walls of its trap located in Prince of Wales Passage on Sunday, August 15, 1920. Indictments were returned against these companies at the Valdez term of the district court in October, 1920.

TERRITORIAL FISH COMMISSION.

The Alaska Territorial Fish Commission was authorized, under the act creating it, to carry on the propagation of food fishes, to protect

and care for the natural spawning grounds of salmon, and to engage in technical investigations respecting the fisheries of Alaska. According to the report of the commission for 1921, the hatchery at Juneau was operated, and a new eyeing station was opened at Eyak Lake near Cordova. In 1921 the commission expended on propagation, including permanent improvements and equipment, a total of $23,157.59, of which $12,358.80 was used in building and operating a station on Eyak Lake in Central Alaska for the partial incubation of red-salmon eggs. The cost of operations at the Juneau hatchery and its subsidiary stations was $10,798.79.

The clearing of salmon streams by the removal of log jams and natural obstructions received the attention of the commission. In the Seward district work was done on Salmon River, Bear Creek, and Grouse Creek. Ptarmigan and Quartz Creeks, tributaries of Kenai Lake, were cleared of several barriers formed by the accumulation of driftwood, thus considerably increasing the area accessible to salmon for spawning beds. Similar work was carried on in southeast Alaska south of Wrangell.

The commission allotted $2,000 for use in Bristol Bay in the destruction of gulls and terns and predacious trout. It expended $2,133.25 in killing hair seals on the Copper River mud flats and reports that 1,325 such seals were slain.

In summing up the season's work of this character the commission reports the destruction of predacious fish as follows: Bristol Bay district, 34,758; Prince William Sound district, 23,000; and Southeast Alaska district, 12,500; making a total of 70,258. The total expenditure for this work, including the allotments for Bristol Bay and Copper River, was $10,089.90.

TERRITORIAL LICENSE LAW.

At the biennial session of the Legislature of Alaska in 1921 chapter 33 of the session laws of 1919, establishing a system of license taxation, was repealed and a new law enacted which became effective from the date of its approval, May 5, 1921. Several changes were made in the rate of taxation of fishery products and of fishing apparatus. The act embraces new legislation, imposing taxes on products and apparatus heretofore untaxed and providing a license fee for all nonresident fishermen operating in Alaska. As it affects the fishery industry, the new law imposes license taxes as follows:

Canneries.—Clam, 2 cents per case; herring, 2 cents per case; salmon, 7 cents per case on kings and reds or sockeyes, 3½ cents per case on medium reds, and 3 cents per case on all others. In addition salmon canneries shall pay 1 per cent of their net annual income.

Salteries.—Mild-cured red king salmon, 10 cents per 100 pounds; mild-cured white king salmon, 5 cents per 100 pounds; salted codfish, 10 cents per 100 pounds; and all other salted and mild-cured fish, 2½ cents per 100 pounds.

Apparatus.—Fish traps, fixed or floating, $200 per annum, so-called dummy traps included; gill nets and stake nets, $2 per 100 fathoms, or fraction thereof; seines, $10 for the first 150 fathoms, and $5 additional for each 25 additional fathoms or fraction thereof.

Fishermen.—Nonresidents of the Territory, $5 per annum. The term "fisherman" shall include all persons employed on a boat engaged in fishing.

Fish buyers.—Dealers in fresh fish, one-tenth of 1 cent per pound on fish purchased, except for sale at retail, whether or not the fish buyer operates a cold-storage plant.

Oil and fertilizer.—Fish oil works and fertilizer plants, 40 cents per 50-gallon barrel for oil and 40 cents per ton for fertilizers and fish meals: whale oil, 50 cents per 50-gallon barrel for oil, and 50 cents per ton for fertilizer.

Under this law the tax on king and red salmon is increased 1½ cents per case. The tax of 2½ cents per 100 pounds is made applicable to salted herring, which was exempt from taxation under the act of 1919. The tax on fish traps is increased $100 per annum, while the tax on gill nets, seines, nonresident fishermen, and fish buyers is new legislation. Oil and fertilizer or meal made wholly or in part from herring were previously taxed at the rate of $2 per barrel and ton, respectively, whereas under the present law fish oil and fertilizer or meal are taxed, respectively, at the rate of 50 cents per gallon and ton. The tax on whale oil is reduced from $1 per barrel to 50 cents, but a tax of 50 cents per ton is levied on fertilizer manufactured from whales, which product was heretofore untaxed.

TERRITORIAL LICENSE TAX.

Under the revenue laws of Alaska, as modified in 1921, license taxes were imposed on dealers in fresh fish and on nonresident fishermen, and higher rates were fixed on products of various classes and on the fishery establishments and apparatus used in the industry. Territorial taxes are payable to the treasurer of Alaska, who furnished a statement on May 2, 1922, covering the collections made to that date for the fiscal year ending December 31, 1921. The treasurer reported that collections were practically complete, probably not more than $5,000 remaining outstanding under the fisheries schedules of the tax law. The total for the calendar year is apparently about $75,000 less than that for 1920.

Fishery license taxes collected by Territory for fiscal year ended December 31, 1921.

Schedule.	Division No. 1.	Division No. 2.	Division No. 3.	Total.
Salmon canneries (pack)	$24,747.07	$1,561.70	$118,663.90	$144,972.67
Salmon canneries (net income)	82.07		4,696.28	4,778.35
Clam canneries			3.04	3.04
Fish traps	28,000.00		18,600.00	46,600.00
Salteries and mild-cure plants	2,406.14	138.17	5,422.94	7,967.25
Fresh-fish dealers	3,073.37		3.70	3,077.07
Cold-storage plants	1,400.00		375.00	1,775.00
Fish-oil works and fertilizer and fish-meal plants	804.40		158.56	962.96
Gill and stake nets	440.50	159.00	5,447.87	6,047.37
Seines	880.00		1,205.00	2,085.00
Total	61,833.55	1,858.87	154,576.[illegible]9	218,268.71

AFOGNAK RESERVATION.

Commercial fishing for salmon in the Afognak Reservation was carried on by 60 natives who were permitted to exercise that privilege under the order of March 21, 1912, and to whom the required licenses were issued. Of this number 45 were residents of Afognak Island and 15 of Spruce Island. Fishing began in May at the important fields of Malina, Paramanoff, Seal Bay, and Little Afognak and was continued until about the middle of August. The catch was sold to the Kadiak Fisheries Co., at Kodiak, and to the Katmai Packing Co., at Uzinki, a new concern in the salmon-canning industry.

The total catch of salmon in the reservation was 192,694, of which 146,123 were sold to the Katmai Packing Co. and 46,571 to the Kadiak Fisheries Co. Compared with the catch in 1920, when 125,538 salmon were taken commercially in the reservation, this is an increase of approximately 53½ per cent. As 90 per cent of the catch in 1921 was red salmon, a further interesting comparison may be made with the catch of that species in 1917, the year of the genesis of the run from which the catch of 1921 was made. In 1917 the number of red salmon taken was 71,527, or approximately 39 per cent of the catch of all species in Afognak waters. In 1921 the catch of red salmon was 173,443, or a gain in one cycle of more than 242 per cent, assuming that they were chiefly four-year fish. Of further interest is the showing that the runs were larger in practically every locality about the island, the most noteworthy increase occurring at Malina. Little doubt can be entertained that this improvement in the run of red salmon was due largely to the beneficial effects of fish-cultural work at the Federal hatchery on Litnik Lake.

The enforcement of the laws and regulations and patrol of the fishing grounds was in the immediate charge of warden William E. Baumann, who made frequent trips to the several streams during the season.

Catch of salmon in waters of the Afognak Reservation in 1921.

Locality.	Coho.	Chum.	Humpback.	King.	Red.	Total.
Malina	71	191	5,923	4	77,147	83,336
Paramanoff Bay		1,004	5,423	6	36,995	43,428
Seal Bay			447	2	14,067	14,516
Little Afognak	1,867	3	97	8	41,329	43,304
Izhut Bay	1	5	2		2,771	2,779
Litnik Bay	4,197					4,197
Pauls Bay					1,134	1,134
Total	6,136	1,203	11,892	20	173,443	192,694

ALEUTIAN ISLANDS RESERVATION.

During the calendar year 1921 no additional permits for fishery operations were issued by the Department of Commerce. Four permits previously granted were canceled, as follows: Nos. 25 and 29, issued to the Northern Fisheries (Inc.) on January 5 and 24, 1918, were canceled February 9, 1921, when the company advised that no further operations were contemplated; No. 34, issued June 29, 1918, to the Alaska Fishing Co., was canceled February 17, 1921, as the company had gone out of business; and No. 38, issued March 25, 1919, to T. R. Gawley, was canceled February 9, 1921, because the permittee advised it was impossible to undertake operations. A total of 22 permits remained in existence at the end of the calendar year 1921. No joint permits by the Departments of Commerce and Agriculture were issued during the calendar year 1921.

Under date of April 30, 1921, a revision of the joint regulations for the administration of the Aleutian Islands Reservation was issued by the Secretaries of Agriculture and Commerce. The sections pertaining to the fisheries are as follows:

REGULATIONS FOR THE ADMINISTRATION OF THE ALEUTIAN ISLANDS RESERVATION, ALASKA.

1. *Jurisdiction.*—In compliance with existing laws and to carry out the objects of the Executive order establishing the Aleutian Islands Reservation, all matters relating to wild birds and game, the propagation of reindeer and of domestic animals, and the propagation and killing of land fur-bearing animals will be under the immediate jurisdiction of the Department of Agriculture; all matters pertaining specifically to walruses, sea lions, fur seals, sea otters, the fisheries, and all aquatic life will be under the immediate jurisdiction of the Department of Commerce; and all matters affecting the reservation other than those specifically mentioned above will be under the joint jurisdiction of the Departments of Agriculture and Commerce.

2. *Residence on reservation.*—Persons residing within the limits of the reservation on April 1, 1921, will be permitted to continue so to reside and carry on any lawful business not interfering with the purposes of the reservation.

3. *Resident permits.*—Residents of the reservation desiring to engage in commercial fishing, or hunting, trapping, or propagating fur-bearing or game animals, or propagating domestic animals, such as sheep, cattle, or reindeer, must first obtain a permit to do so. The Eskimos or Aleutian natives of the islands may hunt and trap without a permit except on islands held under fur-farming permits.

4. *Nonresident permits.*—Anyone desiring to enter the reservation for the purpose of fishing, of hunting, trapping, or propagating fur-bearing or game animals, of propagating sheep, cattle, or reindeer, of engaging in commercial fishing, salmon canning, salmon salting, or otherwise curing or utilizing fish or other aquatic products, or of engaging in any lawful business, must first obtain a permit to do so, but no permit to engage in any of the activities named above will be granted to an alien or to any corporation more than 50 per cent of which is owned by aliens. Permits to enter the reservation for the purpose of engaging in any business will be granted only when the department concerned is convinced that by so doing the objects for which the reservation was established will not be endangered thereby.

5. *Applications for permits.*—Applications for fishing permits should be addressed to the Commissioner of Fisheries, Washington, D. C. Applications for permits to hunt, trap, or propagate land fur-bearing or domestic animals should be addressed to the Reservation Warden, Biological Survey, Unalaska, Alaska.

6. *Fishing permits.*—Applications for permission to engage in fishing or fishery operations should give full information on the following points: Name and permanent address of person or corporation desiring permit; character of business proposed, whether fishing, canning, salting, or otherwise curing fish or other aquatic products; character and extent of proposed plant and its location method and extent of the fishing proposed; place or places where fishing is to be carried on; and when active operations are to begin.

* * * * * * *

11. *Walruses.*—The killing of walruses within the reservation is hereby prohibited at all times.

12. *Sea lions.*—The killing of sea lions on their rookeries or hauling grounds in the reservation is hereby prohibited at all times.

13. *Sea otters.*—The killing of sea otters within the reservation is hereby prohibited until November 1, 1925, and thereafter except under special permit.

14. *Fur seals.*—The killing of fur seals within the reservation is hereby prohibited at all times.

ANNETTE ISLAND FISHERY RESERVE.

Fishery operations within the Annette Island Fishery Reserve were again conducted in the season of 1921 by the Annette Island Packing Co. under its contract with the Department of the Interior. Data in regard to operations have been furnished by the Bureau of Education of that department, which administers the affairs of the reserve for the benefit of the Metlakatla Indians residing therein.

In 1921 the total number of fish taken by traps within the reserve was 747,328, on which a royalty of 1 cent per fish was paid, amounting to $7,473.28. A fee of $200 each for the four traps operated was also paid. In addition 267,525 salmon were taken by natives in purse-

seining operations and were purchased by the company for $9,694.72. The natives received $16,266.06 for cannery labor, and other payments brought the total amount disbursed to the Indians by the Annette Island Packing Co. to $38,392.07, which was $32,674.67 less than in 1919.

BRISTOL BAY DISTRICT.

During the season of 1921 a special force of employees, including a number of temporary men in addition to regular wardens and fish-cultural employees, under the direction of Field Supt. Dennis Winn, was sent as early in the spring as possible to the Bristol Bay district to continue the work of destroying predatory fishes. Efforts were devoted wholly to this work until the beginning of fishing operations, when attention was given also to maintaining a patrol for the prevention of violations of the laws and regulations for the protection of the fisheries. A survey of the spawning grounds was made near the latter end of the season. Part of the expenses of the expedition were paid by a fund provided by the fisheries companies and the Territory of Alaska. A report was submitted by Mr. Winn, as follows:

All suitable help possible was secured in Alaska, but the greater number of the operators needed for this work were of necessity engaged in the States and transportation was granted them, together with all supplies and equipment, on different cannery ships bound for Bristol Bay, as follows:

On the Alaska-Portland Packers Association ship *Berlin* were four men, two launches, and supplies and equipment for Naknek and part of Nushagak. The Columbia River Packers Association transported on the *St. Nicholas* three men, one launch, and a portion of the supplies and equipment for the Nushagak district. The *Abner Coburn*, of Libby, McNeill & Libby, carried six men, together with supplies and equipment for Egegik and Ugashik districts. The *San Juan* of the same company transported two men for Kvichak section. The *Kvichak* of the Alaska Packers Association transported necessary supplies for the Iliamna district, and the *St. Katherine* of the Red Salmon Canning Co. transferred three men to San Francisco on return. The other vessels transporting our men on the return trip were the *Berlin*, four men; *Libby Maine*, one man; *Abner Coburn*, three men; and the *St. Nicholas*, three men.

The employees of the Bureau of Fisheries detailed on this work were Dennis Winn, field superintendent, in charge of the work; J. W. Gardner, foreman, in charge of the Iliamna district; L. G. Wingard, assistant agent, in charge of Kvichak section; Thos. H. Morton, fish-culturist, in charge of Ugashik district; and A. T. Looff, warden, in charge of the Naknek district. Two practical fishermen were also engaged—Harry Savage, in charge of the Nushagak section, and H. B. Looff, in charge of the Egegik section.

TROUT OPERATIONS.

Naknek.—The *Berlin*, with the Naknek party, consisting of Dennis Winn, A. T. Looff, George Rogge, and David McGrath, left Portland April 29, arriving at anchorage off Naknek River May 22. Both launches were placed in the water the following day and the party went ashore. Arrangements were completed and the crew established at the foot of the rapids on May 25, their objective being the lake outlet. As the rapids are about 4 miles in length and are too swift and dangerous for power boats, the equipment and stores had to be lined in dories along the shore. To facilitate the work, it became necessary to clear the brush and obstructions along the entire left bank. After the completion of this work the remainder of the river was easily navigable by Evinrude to the lake outlet, where camp was established and fishing operations were begun immediately.

The activity of trout and terns indicated the presence of small fish, which proved to be migrating salmon. Investigation showed good schools passing downstream. Fishing appliances consisted of set nets, drift nets, fyke nets, set lines, and hand lines. Set nets were by far the most effective. Trolling was conducted, when time permitted, with fair success. Drift nets were tried but were not effective, owing to the numerous large bowlders and snags directly in the channel where the bulk of the trout lie in wait for the oncoming salmon. Practically all of the trout taken were of the lake

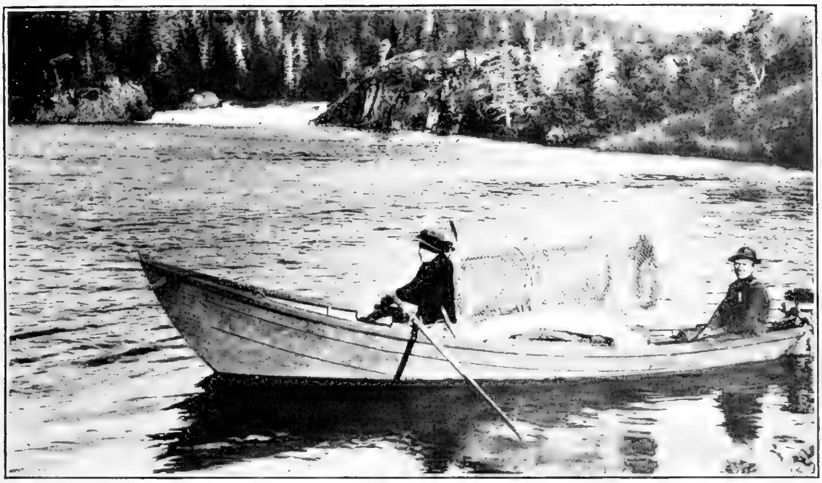

FIG. 2.—TRAP USED IN DESTRUCTION OF PREDATORY FISH, BRISTOL BAY.

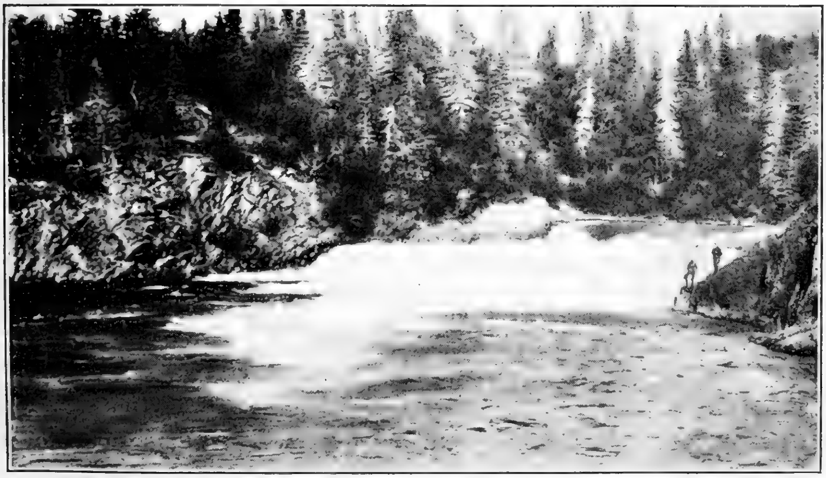

FIG. 3.—KOKHONAK FALLS, BRISTOL BAY REGION, WHERE A PASSAGE FOR ASCENT OF SALMON WAS BLASTED OUT.

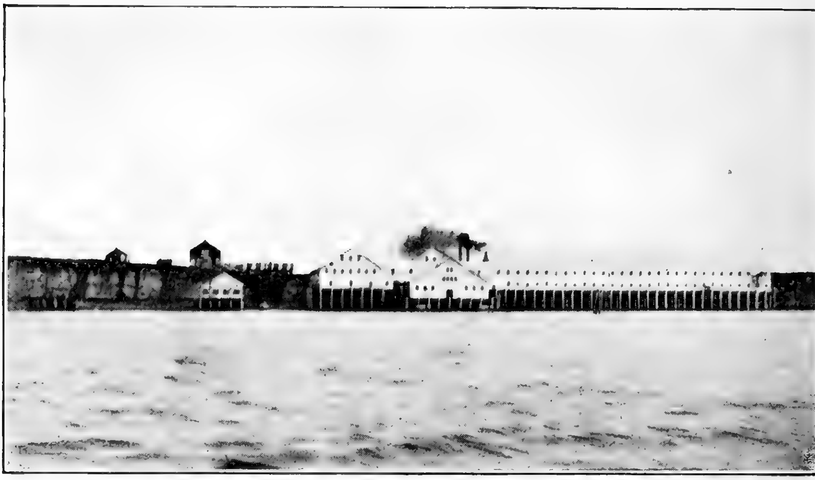

FIG. 4.—TYPICAL SALMON CANNERY, BRISTOL BAY.

FIG. 5.—SALMON SPAWNING GROUNDS, PILE RIVER, BRISTOL BAY REGION.

trout variety, *Cristivomer namaycush*, and all contained young salmon. Some of the trout stomachs examined contained as many as 50 skeletons of small fish and from 10 to 20 red-salmon fingerlings. The skeletons could not be classified, but as there were large schools of young salmon noted, apparently just out of the gravel, it was felt that they could be none other than salmon. Many trout specimens were thin and emaciated from disease. Examination of the eggs indicated spawning in the fall. It was noted on several occasions that the trout would pass downstream with the migrating salmon in the evening and the following morning would be back as usual to await the coming of another school. It would appear that they followed the salmon to about the head of the rapids. In 1920 some trout were taken below that point, but not in any numbers. During the period the trout were absent the terns, which were always in evidence, would disappear also, only to return with the trout.

About the middle of June the catch began to fall off rapidly. Examination of trout stomachs showed the presence of migrating salmon, and it was felt that the fishing was responsible for the diminishing numbers. It was decided then to move camp to the mouth of Kidawik Creek. A storm on the lake delayed the transfer, but camp was finally established the 18th. Fishing appliances were set out, and work on blasting a fishway over the dam obstructing Kidawik Creek was immediately begun. The obstruction was a ledge of conglomerate rock extending across the entire stream, forming a perpendicular fall from 6 to 8 feet in height that was practically impassable to ascending salmon, except in high-water periods. A satisfactory passage 15 feet in width, sloping back 25 feet from the base, was blasted over the left edge of the falls, over which the fish can now pass without difficulty. This opens about a mile and a half of ideal spawning ground in the creek and permits free passage to Toms Lake at its head, a wonderful body of water 15 miles long by 3 miles wide.

Prospectors and natives advised as to the names of Kidawik Creek and Toms Lake, which were used in 1920, hence their use in this report. Robert F. Griggs, in his article "The valley of ten thousand smokes," in the National Geographic Magazine of September, 1921, has renamed these waters "Brooks Creek" and "Brooks Lake."

On August 6 a trip was made up the creek and around the lake. The creek was alive with fish both above and below the falls, as was the outlet to the lake. No salmon, however, were noted farther up the lake, although likely spawning territory was noted near the head. Very little spawning, however, was under way at that date, which may account for the nonappearance of salmon farther up. Fishing was conducted as aggressively as possible in connection with the work on the barrier. The total catch for the season was 1,583 fish, averaging 10 pounds each, or 15,830 pounds. Work was discontinued August 8, and the employees were transferred to the Alaska-Portland Packers Association cannery for the return trip on the *Berlin*. The equipment was stored at the cannery, where also the launch was placed on the ways.

Egegik.—The Egegik party, consisting of H. B. Looff, Karl Kreamer, and Edward Jackson, was put ashore at Egegik May 29, by a Libby, McNeill & Libby boat, and permission was granted by the company's superintendent, P. K. Clausen, to store supplies to be drawn upon as needed. An Evinrude engine was assembled and ends of dories cut down and arranged to receive same as an outboard motor.

A storm of three days' duration prevented immediate departure upstream, but camp was finally established at the rapids near the outlet of the lake on June 5. The lake was still filled with ice, but migrating salmon were observed passing downstream. The last of the migration noted was June 10, which would indicate that the main portion passed out before our arrival. For several days the ice interfered with and at times prevented fishing, but fair work was accomplished. Stomachs of trout, all Dolly Vardens, were examined and without exception contained young salmon. Terns, too, were always in evidence. The lake was clear of ice June 12, but severe weather prevented moving before June 16. Camp was finally located at the head of Little Becharof Lake on Kanatak Creek, which, with the lake at its head, is considered the main red salmon stream of this section.

The principal spawning grounds in this sector are those in Little Becharof Lake and its tributaries, which latter number 11 streams well suited for and occupied by spawning red salmon, as were the entire east and west shores and part of the south shore of Little Becharof Lake. Several minor streams were noted, each containing its quota, estimated at from 100,000 fish at Kanatak Creek, the most important, to about 5,000 fish at Point Creek, which is small and of limited capacity. An estimate of the number of fish in the sector was placed at 327,000 July 30, so it will be readily understood that by far the greater portion of the fish due each stream were yet in the lake and only the early run had reached the creeks. Natives living at Kanatak Village for the last 10 years report this year's run the largest reaching the lake in their time. The salmon all appeared to be in good condition.

Trout as large as the salmon were observed entering the lake with them. Operations were conducted in all streams successively, and as each creek was cleared of trout the camp was moved to the next until the entire lake was circled. The most successful method of capture was to set a seine across the stream near its mouth and then drift downstream with a gill net driving all the trout in the stream to the seine, which was hauled ashore. Specimens weighing 9¾ pounds were taken. The entire lake shore and all the tributaries were visited several times by the operators in the course of their fishing activities with good results. During the early part of the season, before the salmon arrived, the natives kept in close touch with the operators and received all the fish taken, so there was no waste.

Operations came to a close August 10, with a total catch of 7,621 fish, which averaged 2½ pounds each, or 19,052 pounds, practically all being Dolly Vardens. The crew returned to the Egegik cannery of Libby, McNeill & Libby, stored equipment, and left on the *Abner Coburn* for Seattle August 13.

Ugashik.—A party of three in charge of Thomas H. Morton was transported to Bristol Bay on the *Abner Coburn* and transferred to Ugashik on the *Curlew*, of the Alaska Packers Association, arriving at the latter point June 5. Dories and freight were unloaded and a start made upstream the following morning. The party arrived at the Red Salmon Canning Co.'s cannery and through the courtesy of the superintendent the mess supplies were stored and a base established. The following day the party proceeded upstream on the flood tide, arriving in the evening at the rapids, near the head of the river, where camp was established for the night. Camp was moved the next morning to the head of the rapids, where permanent camp was made and operations begun.

Large schools of migrating salmon were noticed passing downstream. Several large Dolly Vardens were taken the first evening, but very few were in evidence. The water was crystal clear, so that any number of fish would be easily noticeable. In attempting to fish with a fyke net the migrating salmon entered in such numbers that it was necessary to remove it from the water within a few hours for fear of serious losses. A heavy migration was observed at the time of our arrival, but as all passed downstream within a few days thereafter, it is felt that the main body passed out earlier and we could only observe the tail end.

As operations here were unsatisfactory, camp was moved across the lake and established on the stream connecting the two Ugashik lakes, where fair results were obtained. Most of the fish taken were Dolly Vardens, some weighing 8 pounds, with about half as many lake trout. These latter, unlike those at other points, were small, averaging 3 pounds. Trips were made around both lakes in an endeavor to locate trout in any numbers. Some promising salmon streams were noted, but few trout were located. No numbers of predatory fish were noted anywhere until the ascent of the adult salmon, when they were noted ascending with them, some fully as large as the salmon, after which our best catches were made. The wire traps proved the most successful at this point, most of the fish being taken in this manner after we were able to secure salmon for bait, the trout not being particularly anxious for flesh of their own kind. Moderate success was secured with drift nets operated after dark, as also with set lines and bait. About July 20 the trout and also the few grayling taken were found to be full of salmon fry just leaving the gravel. The Dolly Vardens taken all appeared to be sea-run fish just arrived. The total number of fish taken was 6,388, averaging 2¾ pounds, or 17,567 pounds.

Practically the entire shores of both lakes have fine clear gravel beaches, and schools of salmon were noticed almost everywhere along them. It was found to be impossible to estimate the number of salmon in the lakes in the limited time, but, in the opinion of the foreman, a practical fish-culturist who has had experience at collecting stations, there were large numbers in the lakes and tributaries, which would indicate an excellent escapement. Very few fish had entered the tributary creeks before our departure, only one stream seeming destined to receive any number. It was a large stream entering the east side of the lower lake, where several good schools were noticed near its mouth.

Nushagak.—Harry Savage, with two assistants, was transported on the *St. Nicholas* from Astoria, arriving at Nushagak anchorage on May 23. The patrol launch was placed in the water the following day and supplies and equipment were transferred to the Alaska-Portland Packers Association cannery at Snag Point, where a base was established for this sector.

Necessary supplies and equipment were taken on the launch and in a towed dory, and a trip made to the lake outlet on the 26th. Ice in the lake precluded the possibility of proceeding up the lake before June 12. Fishing was conducted as aggressively as possible at the outlet, but as there was no migration as yet the trout did not school and those taken were scattered over a large area. As soon as the ice permitted passage

up the lake camp was transferred and fishing was conducted at the mouth of the river connecting Aleknagik with Nerka Lake, at the same point where good success was had last year. The small run of migrating salmon and the consequent scattering of trout made the work discouraging through the early stages and the centralization of operations impossible. The fish taken early were not as large as those captured last year, but toward the latter part of June when the salmon began making their appearance the migration increased, trout became more numerous, and better catches were made. It also became necessary to remove the gill nets from the water, owing to the rush of salmon. Fyke traps and hand lines were resorted to with fair success. The trout entered from the sea with the salmon, making it impossible to use other or more destructive gear. The trout destroyed numbered 12,702, averaging 3½ pounds each, or 44,457 pounds. Work was discontinued August 6, equipment stored at the Alaska-Portland Packers Association cannery, and the *St. Nicholas* boarded August 8 for the return trip.

Iliamna sector.—In order to reach the streams tributary to the Upper Iliamna Lake, J. W. Gardner, with an assistant, was instructed to proceed via regular steamer to Anchorage, thence across Cook Inlet by launch to Iliamna Bay, and from that point to Iliamna Village over the portage. Supplies and equipment were taken over the portage by natives with dog teams. This party left Seattle April 13, arriving at Iliamna Village on April 28. All supplies were hauled across by the 30th.

The lake was still frozen over on arrival, and work was begun on the Iliamna River, which was open. Although the people living in that vicinity always claimed great numbers of trout were present in the spring, our party found almost none. The river was thoroughly examined with little encouragement or result. Several trips were made over the trail to Pile River at the head of the lake, and set nets were carried over and placed in likely places near the river's mouth, but poor results attended operations here also. Nor were there many trout noticed in investigations up river for several miles. These rivers were fished continually, and as the ice began disappearing in the upper end of the lake the operations were extended and transferred from point to point wherever indications were favorable, but the total results were small.

Travel became possible across the upper end of the lake about June 1, when a launch was secured and supplies and equipment taken to the mouth of Newhalen River, where a permanent camp was established. Extensive operations were carried on. Floating ice interfered with the work for a few days, or until it all passed out into the lake. Several of the nets were carried away, although all but one were recovered. The ice disappeared rapidly, and it now being safe to cross the lake, a trip was made to Kokhonak Creek in hopes of establishing a station there, but conditions were unsuitable. The lake was extremely low and the creek high, making it impossible to attempt any net work. Several streams that might present possibilities were visited, but by far the most promising one was Copper River at the head of Intricate Bay, and a camp was established there on June 10.

Most of the ice was out of the lake by this time, and a trip was made to Bristol Bay for supplies. Some ice was encountered on the way down the river, but no danger was anticipated and the trip was made without incident. As soon as the Kvichak River was open and passage was possible, Lemuel G. Wingard, with patrol boat *No. 1*, was dispatched to the lake with the necessary supplies for the party, and also to make a survey of trout possibilities in the vicinity of the flats in upper reaches of the river. The boat arrived at the foot of the flats, but owing to the extreme low water in the river was compelled to anchor. An ice floe passing down complicated matters by turning over the dory in tow with a load of supplies and equipment, and endangered the launch. Nearly all the equipment and supplies were salvaged, after which Mr. Wingard returned to Koggiung to await the arrival of the smaller boat from the lake. On the return of the small launch to the lake all streams were visited and fishing attempted, but at no point were good numbers of trout encountered. A great drawback was the lateness of the season, which prevented work being attempted at the different streams before the trout were back in the lake after spawning.

As few migrating salmon were noticed passing from Lake Clark through the Newhalen River, it is felt that the migration had practically passed by that point before we were able to establish camp there. Through the spring and summer months the only time the Dolly Vardens and lake trout are to be encountered in large numbers is when schools of salmon are migrating. Throughout the season the trout were scattered and most difficult to locate and catch. The greatest success was had at points where the natives were drying their winter's supply of fish and baiting the locality with refuse and fish scraps from the cleaning. The total number of trout taken for the season was 6,464, weighing 25,856 pounds.

At the close of the season the bureau's launch was placed on the ways at Goose Bay and left in care of Mr. Millett, who has a launch of his own at the same point. Supplies were stored at Foss Ranch for use early next season, which does away with the necessity of the purchase of any supplies except perishables before the arrival of the cannery fleet. After this work was accomplished the party returned to Iliamna Village, thence over the portage to the bay and via launch to Anchorage, by rail to Seward, and thence by regular steamer to Seattle, arriving September 29.

At Kokhonak Falls a fishway was blasted out of the rock through which it was hoped the fish could pass into the river above. A cut was made in the rock about 30 inches wide by 3 feet deep and 10 feet long, with a 20 per cent drop, carrying about 1 foot of water, which flowed into a large pocket, then through a series of natural pockets to the foot of the falls. The fish ascend with little difficulty to the large pocket but find trouble in reaching the last pocket at the foot of the cut, where a leap of about 4 feet is necessary. As the pocket is comparatively shallow, the fish are unable to get sufficient power for the leap, although some accomplish it. More blasting and possibly some flume work will be necessary to make the passage thoroughly efficient. The location of the fishway is excellent, as it is protected by a rock bluff projection from the shore which precludes damage from ice or drift, and also has the advantage of being the side where salmon are most in evidence endeavoring to ascend. It was estimated that 1,500 red salmon were working at the falls and some were spawning near its base in comparatively deep water on our last visit August 20, about three times as many as the previous year.

Summary.—The lateness of the spring season interfered greatly with the work, as in most cases the migration was nearly over before the ice had left the lakes. At both Iliamna and at Wood River the small migration was a contributing factor, as the attraction was not sufficient for large schooling of trout. The total take for the season was 34,758 fish, totaling 122,762 pounds.

RUNS OF SALMON.

While the number of fish ascending was more than double that of the preceding year, the run was of such short duration that no large individual packs were possible. It was estimated that about 950,000 cases of salmon were packed during the season, practically all reds. All canneries curtailed their preparations at least 20 per cent of capacity, but their packs fell short of anticipation.

Salmon in large numbers first made their appearance July 1 in the Kvichak River and the following day in the Naknek River and vicinity. In the Nushagak sector the run began July 5. At each point the numbers immediately increased to such proportions that the different canneries, with one or two exceptions, set a limit of 1,200 fish per boat, which condition continued over a period of about a week, when the run tapered off rapidly and the limit was removed, but the crest of the run had passed and few large catches were again reported. An increase was noted July 15, but immediately the run fell to small and, in most cases, unprofitable catches.

ESCAPEMENT.

While the escapement in the different rivers and lakes was excellent, it is believed to be due in part to the efficiency of the stream patrols. An estimate of the numbers reaching the lakes is as follows:

Wood River	1,000,000
Kvichak River	1,000,000
Naknek River	800,000
Egegik River	500,000
Ugashik River	500,000

The run was inspected in the different rivers and checked as nearly as possible, and while the estimate is known to be faulty, it is believed to be close enough for purposes of future observations.

Observations were almost wholly in regard to red salmon, but other species were noted in the Naknek-Kvichak section in rather small numbers. In passing up the Naknek River visits were made to each tributary stream. There were but two of any importance in connection with the salmon runs—King Salmon Creek and Ralph River. The former, about 12 miles up, is small but has fair possibilities. King salmon were noted ascending in small numbers. Later fair numbers were observed spawning in the main river over a stretch of about 3 miles below the foot of the rapids. Ralph River, a tributary about 7 miles below the rapids, is a fair body of water with

good possibilities. Practically all the silver salmon entering the Naknek ascend this stream. This evidently comprises the extent of the territory in this section occupied by the species mentioned. In the Kvichak River the king salmon ascend Kaskanak Creek but were not noted above that point. Humpback salmon ascend to Kaskanak Flats and spawn in the main river in that vicinity. Red salmon enter the Alagnak River and proceed to extensive lake areas at its head.

PATROL.

There were available for patrol work three launches, each 30 feet long by 9 feet beam, Columbia River type, with comfortable house over all, powered with 8 horsepower heavy duty Union engines and fitted with berths for three men, also stove and necessary mess equipment for living aboard. These launches were used for patrol in the Kvichak, Naknek, and Nushagak sections, and dories with Evinrude outboard motors were used in the Igushik, Egegik, and Ugashik regions. While the launches are thoroughly efficient in the rivers and several trips were made across the bay, they are not suited at all times for outside waters, especially during heavy weather. For this work the bureau should have a safe, well-powered boat 45 to 50 feet in length for use between the different stations, which would enable the directing officer to keep in touch with the wardens; also for assistance when the marshal serves warrants and transports law violators. One serious drawback at present is the difficulty of serving warrants, owing to the distance apart of the commissioner and marshal. The former lives at Koggiung and the latter at Dillingham. The stream patrol at the different points began June 20 and continued through July 25, when commercial fishing became unprofitable. No nets were permitted in the water above any prohibitive markers other than by natives for their home use exclusively.

Kvichak District.—Assistant Agent L. G. Wingard and his assistant arrived at Naknek on May 13, where they were busily engaged in placing prohibitive markers at mouths of the different rivers in the Naknek-Kvichak district and posting signs at the different canneries relative to the prohibited area until the arrival of the ships on May 23. When the patrol launches were lowered into the water, *No. 1* was turned over to Mr. Wingard with instructions to proceed to the Alaska Packers Association cannery at Koggiung. From June 20 to July 28 an efficient patrol was maintained in the Kvichak River by circulating back and forth in the vicinity of the prohibitive markers and above. Few extreme cases of law violations were encountered at any point. These were successfully prosecuted, and reports were duly made by Mr. Wingard. He returned to Seattle on the *Libby Maine*, of Libby, McNeill & Libby, and his assistant proceeded on the *Berlin*, of the Alaska-Portland Packers Association.

Naknek.—Warden A. T. Looff, with patrol boat *No. 2*, was assigned to the Naknek River and was thoroughly effective. The method employed was to keep circulating in the mouth of the river among the fishermen and tally scows, and as the boat was always in evidence it had a wholesome effect with the result that there were few attempts to trespass. Two cases of violations were reported but were not brought to trial because of the absence of the marshal from Naknek and the subsequent ordering of the bureau's representatives to other localities, which prevented their appearance to prosecute the cases.

Nushagak District.—Harry Savage was placed in charge of patrol boat *No. 3*, with warden supervision over the Nushagak section. His work was similar to that in the other districts mentioned and was entirely satisfactory. No attempts were made to trespass above the prohibitive markers in any of the streams. These markers or monuments were erected by the writer before the fishing season opened. A camp was established at the mouth of the Igushik River, and G. E. Madden was placed in charge as stream watchman, his equipment consisting of a dory with Evinrude outboard motor. It was an easy stream to police, and no infractions of regulations occurred.

Egegik River.—This section was patrolled by William Jackson, who camped near the Libby, McNeill & Libby cannery, where the markers were located, his mode of travel being by dory with Evinrude outboard motor. He had no difficulty in enforcing the regulations. The river is easily handled, as the markers are at the canneries of Libby, McNeill & Libby and the Alaska Packers Association on opposite sides of the river, and fishermen have no occasion to proceed farther upstream in the performance of their duties. No infringements were reported.

Ugashik River.—Thomas Morton, with equipment similar to that in the Egegik River, patrolled this river to the best of his ability but with unsatisfactory results because of the fact that one of the larger patrol boats could not be placed at his disposal. It is hoped that this situation will be remedied another season by providing a launch

with very shallow draft, Columbia River type, with 6-horsepower Union engine encased, the boat to be fitted with sail and tent cover like the regular fishing vessels. This would be thoroughly suitable for the work and would insure satisfactory living conditions for the stream guard.

SPAWNING GROUNDS.

The spawning grounds were all visited throughout the Iliamna district, and although the escapement was large the spawning area is so vast that while each tributary stream contained fish none appeared crowded, the greater numbers occupying the streams at the lower ends of both Iliamna and Clark Lakes. Some of the tributaries at the upper ends of both lakes contained but small numbers. It was reported, however, that the salmon arrive at the upper end of Lake Clark late in the season, which may also be true of Iliamna. A reliable resident at each point will keep close watch and make a record for future use. However, no salmon made their appearance last year at the head of Lake Clark at the time of the inspection or later. The principal spawning streams of the Iliamna Lake district are along the southeast shore with considerable spawning at different points on the lake shore. These streams were visited when the spawning was at its height for the purpose of inspecting the spawning area. Passing from Kvichak River, various streams were visited where the following observations were made:

Belinda Creek.—A fair run entered this stream but was drawn upon heavily by natives for their winter supply. Several thousand dried fish were in caches, and more were in the process of curing. A trip was made a few miles upstream, where a fair number of fish were noted on the beds. This stream is small and therefore limited in capacity. About 25,000 fish were seen on the beds.

Prospect Creek.—There were a few fish around the inside of the mouth of this stream, but no numbers were observed on the trip, and possibilities were meager.

Kokhonak Creek.—This is one of the best salmon streams in the system. It is an ideal stream, about 6 miles long by 65 feet wide, and is practically all used by spawning fish. A trip was made with a poling boat up the creek to Kokhonak Creek Lake at its head. A peculiar circumstance in connection with this lake is that, although it is a wonderful body of water 10 miles long by 3 miles in width, no fish ascend above its outlet, and no spawning was observed along its shores. Fish in large numbers ascend to a small creek close to the lake outlet, up which they pass in great hordes. While the creek is well supplied, none of the fish seem at all interested in the lake. An estimate was made of about 250,000 fish in this stream.

Kokhonak River.—About 1,500 red salmon were observed endeavoring to negotiate the falls, but although considerable work had been done in blasting out a fishway few could make the passage, and more work will be necessary the coming season. The opening of this passage will make available many miles of ideal spawning country. The fish were spawning in about 9 feet of water near the foot of the falls.

Copper River.—This is considered the best salmon stream entering Lake Iliamna. It is situated at the head of Intricate Bay, and finding the stream is indeed intricate, owing to the numerous islands and passageways. Investigations covered 10 miles in a poling boat upstream. Copper River is about 70 feet wide by 18 to 24 inches deep, with a 3-mile current. The entire bottom is suitable for spawning, and the fish were evenly distributed over its full length. Sloughs on each side of the river contained fish and nearly doubled the spawning area of the stream. It was estimated that there were about 300,000 red salmon in the stream. Many small creeks along the shore of Iliamna Lake to Iliamna River were visited, but their possibilities were so meager as to be almost negligible.

Iliamna River.—Investigations were undertaken upstream for a distance of about 14 miles. While the ratio was five to six times greater than last year at different points, the number noticed did not exceed 6,000 salmon for the entire season.

Pile River.—This stream was investigated for several miles, but few fish were noted. It has never possessed a reputation for numbers of fish.

Knutson Creek.—Knutson Creek is at the head of Knutson Bay and is small, with limited possibilities; the creek proper has none. Several small spring creeks and sloughs tributary to the creek contained fish, although in small numbers. About 1,000 fish were noted in this section.

Chekok Creek.—A fair number of salmon were observed here and in the bay. A trip was made upstream several miles to a point where there are numerous small spring ponds tributary to the creek. Eight of these ponds, each being about 100 feet in diameter and containing from 200 to 1,000 fish, have bottoms thoroughly suited for spawning purposes. It is said that they seldom freeze and never contain more than a thin coating of ice. Some, however, contained water not over 18 to 24 inches

in depth, and many gulls were working on the eggs. Two small creeks near the Iliamna-Lake Clark portage contained good numbers of fish. The season was well advanced. On the northwest shore a visit was made to Upper and Lower Tularic Creeks about the middle of July. Few fish were in the streams at that time, but good numbers were observed near the stream mouths. As there are no harbors on that shore for storm protection, a trip is not deemed safe during the fall months.

Lake Clark.—All the streams in this section were visited, but very little spawning was observed in the upper reaches of the lake. Spawning salmon were noticed in good numbers along the entire length of Newhalen River, and each of the several small tributaries contained some fish. Aleck C. Creek, a tributary near the head of the river, contained fair numbers of fish. Early in the season a large run passed up this stream to a lake at its head, and the natives seined about 8,000 fish at its mouth in a few days and prepared them for dog feed.

A small number of fish were seen in Tazimina River, beginning about 3 miles from its mouth and extending to the falls 4 or 5 miles farther up. Fish became scarcer advancing up the lake, and in the upper reaches the only specimens noticed were on the spawning grounds along the south shore in the vicinity of Tarnalia River, about halfway up the lake, and in Kegik Creek and Kegik Lake on the north shore. Few fish were seen in the creek, for the water, like that of nearly all the streams in this system, was greatly discolored because of warm weather and because it was glacier fed. Proceeding to Kegik Lake encouraging numbers were seen spawning and schooling near the mouths of two excellent creeks at the head of the lake. None had as yet entered the creeks, which presented ideal spawning possibilities. According to the natives late runs enter here and live fish are observed through the ice in January.

All other streams were visited but no fish were noticed, and none were observed along the north shore of the lake, where previously it had been stated the bulk of the spawning in this field occurred. While an estimate of 1,000,000 fish was made as to the escapement into the Kvichak, the available spawning area could easily accommodate at least three times that number without detriment.

RECOMMENDATIONS.

It is recommended that powers be extended to the officer in charge to make arrests in accordance with the sense of the foregoing report. This plan would necessitate the use of a suitable seagoing launch for the officer in charge, somewhat larger than those now in use, so trips could be made at any time between the different stations without endangering lives or property.

It is suggested that the bureau permit one or two men to winter in Bristol Bay, so as to gather all information possible about the spawning grounds of both salmon and trout in some special section, preferably Wood River. Available information indicates that the trout drop downstream into the lakes after spawning, when the ice begins forming in the creeks. If such could be proved to be a fact, the work could be planned to better advantage in dealing with trout destruction. In order to determine this, it will be necessary to remain in that locality through the winter, as there are no facilities for leaving after the information is obtained. A suitable launch should be secured for the Ugashik work.

In order to make the fishing regulations more efficient there should be a deputy marshal and a commissioner in the vicinity of Naknek, as there is difficulty in getting a marshal to serve warrants or a commissioner to have them executed in the absence of a marshal, as was the case this last season. The commissioner is at Koggiung and the marshal at Dillingham, making it extremely difficult to get action.

Originally it was felt that the run of the year 1921 should be fair and 1922 good. However, the former fell far below expectations, and it is only reasonable to assume from the above basis that the coming year will be somewhat disappointing. As a safeguard it is recommended that a curtailment be made in the pack for the year 1922 equal to that of the year 1921.

COPPER RIVER FISHERY.

The Copper River is the most important red-salmon stream on the mainland of central Alaska. It produces a run of red salmon that in quality is not excelled by that of any other section of Alaska. The run is not large, however, and it has been impaired in recent years through increased fishing operations, not only in the river

proper and its several outlets, but in the contiguous waters of the delta also.

In 1921 seven canning companies and two mild-curing operators took Salmon from Copper River waters. Of these the Alaska Sea Food Co., Carlisle Packing Co., Eyak River Packing Co., Hayes Graham Fish Co., Hillery-Scott Co., Pioneer Packing Co., A. Colussi, and S. S. Lee carried on fishing in the delta district, while all fishing at Miles Lake and Abercrombie Canyon was done for the F. H. Madden cannery at Abercrombie. The Hoonah Packing Co. and the Canoe Pass Packing Co. did not operate.

Gill nets, staked and drifting, were universally used in all Copper River waters, except at Abercrombie Canyon, where dip nets were used exclusively. In the delta region 34,125 fathoms of nets were operated and in Miles Lake 2,275 fathoms were used, making a total of 36,400 fathoms for the district. The number of dip netters who fished in the canyon varied during the season, 55 being the maximum number engaged at any time. As compared with similar statistics in 1920, reports for 1921 show a decrease of 11,875 fathoms in apparatus used in delta waters and 1,952 fathoms in Miles Lake, or a total of 13,827 fathoms for the entire field.

During the fishing season inquiry was made at Chitina, Copper Center, and other up-river points regarding the escapement of salmon and the supply secured by the Indians for domestic purposes. Later observations were made by Assistant Agent Shirley A. Baker at Klutina, Gulkana, and Summit Lakes as to the condition and use of the spawning grounds, but no evidence was found to indicate that the escapement was adequate to maintain the runs. More salmon were observed in Gulkana Lake than in the other waters visited, and the opinion was generally expressed by residents of the Copper River valley that more salmon reached the upper river and the main tributaries in 1921 than in either of the two seasons immediately preceding.

Catch of salmon in Copper River from 1916 to 1921, inclusive, by locality and species.

Locality and species.	1916	1917	1918	1919	1920	1921
Delta district:						
Cohos	79,396	55,564	36,247	24,872	55,484	....
Kings	5,440	5,134	4,292	8,972	15,086	8,224
Reds	300,157	455,001	745,522	1,096,090	700,342	415,426
Humpbacks	31,578	....	....	....	....	....
Total	416,571	515,699	786,061	1,129,934	770,912	423,650
Lake and Canyon district:						
Cohos	36,034	36,839	25,509	15,778	18,440	377
Kings	8,765	8,050	14,806	4,092	6,345	2,429
Reds	407,980	309,324	484,607	157,597	150,755	76,937
Total	452,779	354,213	524,922	177,467	175,540	79,743
Grand total	869,350	869,912	1,310,983	1,307,401	946,452	503,393

Interesting observations were made at the Abercrombie cannery in respect to the unequal proportion of male and female salmon taken at the lake and canyon fisheries. In June three counts, aggregating 800 salmon, gave 701 females and 99 males. Between July 1 and 15 eight similar counts, totaling 1,200 salmon, gave 986 females and 214

males. Seven counts from July 15 to 31, totaling 1,100 salmon, showed 708 females and 392 males. From August 2 to 15 a total of 900 salmon counted resulted in 420 females and 480 males. All counts were made without selection at the iron chink from the day's run of salmon through that machine.

The counts showed that at the beginning of operations in the canyon 88 per cent of the red salmon caught were females. Later the proportions changed, females constituting 82 per cent of the catch in the first part of July and 64 per cent the latter part, and in August only 46 per cent were females. It seems probable that the smaller percentage of males caught at the beginning of up-river operations was due to the screening effect of the gill nets at the delta, in that the smaller salmon, chiefly females, escaped through the meshes.

At the Seattle hearing on November 17, 1921, at which Mr. C. H. Huston, Assistant Secretary of Commerce, was present, the owners of the Abercrombie cannery introduced evidence to the effect that there was an abundance of salmon in the Copper River sufficient for the needs of the inhabitants of the region and ample to maintain the runs over and above the limited demands of their cannery, and that in view of these representations the closing order of December 18, 1920, prohibiting all commercial fishing in the Copper River on and after September 1, 1921, should be set aside. Contrary views were convincingly expressed, especially by Dr. C. H. Gilbert, who has made extensive studies and observations in the region. In the final analysis of the information presented the conclusion was reached that adequate protection of the Copper River salmon runs was unattainable under any relaxation of the closing order.

KARLUK INVESTIGATIONS.

Special work was inaugurated at Karluk in May, 1921, to secure data for the solution of problems of great importance to the salmon industry of Alaska, among which are (1) the ratio of utilization to escapement of salmon from any run that is sufficient to safeguard and maintain the supply, and (2) the production of salmon under natural conditions from a known escapement. These questions can not be answered in a single season, but painstaking inquiry and investigation must go on through several years without interruption before the necessary data can be obtained.

Karluk River seemed to possess peculiar advantages for this undertaking, as there is no complication of the questions under consideration by the mixture of salmon destined to other spawning grounds. A rack was placed across the river at a point approximately half a mile above the lagoon at the head of tidewater. It was equipped with three gates through which the ascending salmon were permitted to pass, a daily tally being kept of the salmon escaping. Counting began on May 26 and was continued until October 27. Broadly speaking, the escapement was good, but at times the effect of fishing at the mouth of the river was marked, as some days approximately 90 per cent of the run was captured.

Interesting observations were made regarding the migration of fingerling salmon which in the early part of June were noted in thousands at the rack. Specimens were collected for identification. Dolly Varden trout were also descending the river in large numbers

from May 28 to June 10, but by the middle of June the migration had ceased. Dolly Vardens were first noticed ascending the river on July 9.

YUKON RIVER FISHERY.

Commercial fishing for export on the Yukon River was resumed in 1921 by the Carlisle Packing Co., which operated a floating cannery on Kwiguk Slough, and by W. F. O'Connor, who was chiefly engaged in pickling salmon. In addition N. L. Holmgren and Jacobsgaard & Jorgenson made small packs of salted salmon, and Waechter Bros. Co. were interested in mild-curing and freezing operations.

Fishing was carried on in the south mouth of the Yukon, known as Kwikluak Pass, and in the coastal waters immediately off the mouth. The apparatus consisted of 8,850 fathoms of gill nets, 1 trap, and 2 wheels. The species and numbers of salmon taken were as follows: Cohos, 1,000; chums, 111,098; and kings, 69,646; a total of 181,744. Of these 51,624 chums and 34,807 kings were reported as having been caught outside the river in waters unaffected by departmental regulations.

The products prepared for export were 19,435 cases of kings, 6,867 cases of chums, 124 tierces of mild cured kings, 8 barrels of pickled cohos, 53 barrels of pickled chums, 24 barrels of pickled kings, 3,203 pounds of frozen chums, and 19,549 pounds of frozen kings. The value of the products was $331,079. Employment was given to 172 whites, 58 natives, 33 Japanese, and 1 negro. The total investment was approximately $522,224.

No record could be obtained of the number of salmon taken from the Yukon by Indians for local consumption, but it may be fairly assumed that their catch aggregated several hundred thousand salmon. Though some localities reported fair catches, the concensus of opinion was that the runs of salmon were small and that an adequate supply of fish for the inhabitants of the Yukon Valley could hardly be secured.

By the order of December 18, 1920, commercial fishing in Yukon waters for export was prohibited indefinitely on and after September 1, 1921. At a hearing in Seattle on November 17, 1921, at which Mr. C. H. Huston, Assistant Secretary of Commerce, was present, the Carlisle Packing Co. submitted documentary and oral statements to show that the runs of salmon in the Yukon were large; that the commercial catch had not appreciably affected the supply; and that the closing order should be set aside, so that fishing in the river could be carried on in 1922.

These contentions were opposed orally by Dr. Charles H. Gilbert, of Stanford University, speaking for the bureau; by Bishop Peter T. Rowe, an eminent Episcopalian missionary of long residence in Alaska, for and in behalf of a large part of the native population of the region; and, further, by many unsolicited communications from persons who by intimate knowledge of conditions were able to contribute important information regarding the supply of salmon. After a careful review of all the evidence submitted no satisfactory reason appeared to exist for a suspension of the closing order.

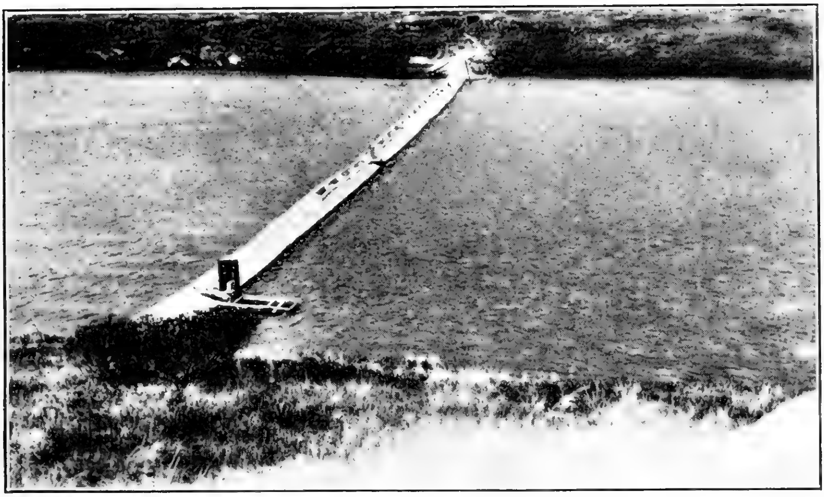

FIG. 6.—RACK IN KARLUK RIVER FOR COUNTING OF SALMON ASCENDING TO SPAWNING GROUNDS.

FIG. 7.—LOWER KARLUK RIVER, SHOWING MOUTH IN DISTANCE.

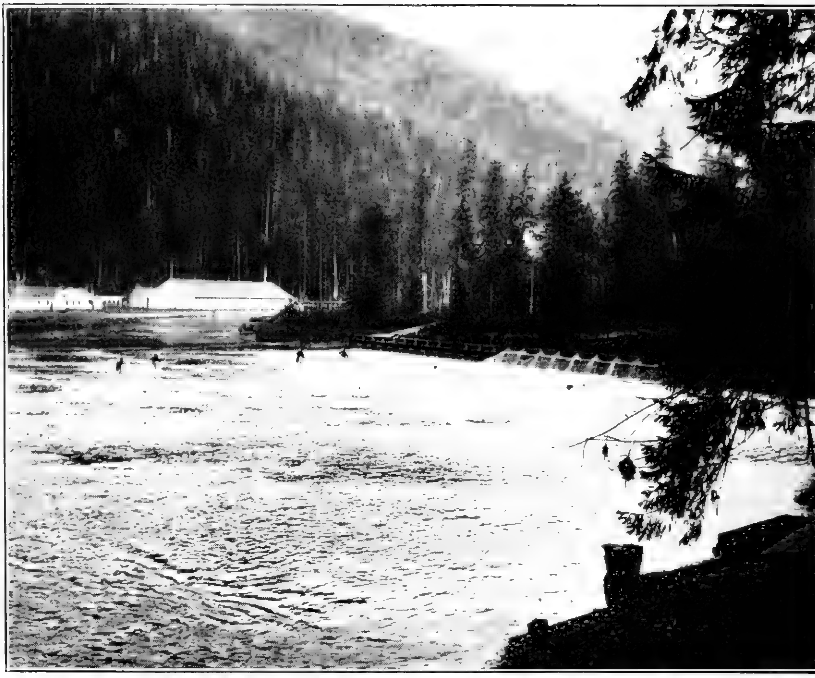

FIG. 8.—GOVERNMENT SALMON HATCHERY, MCDONALD LAKE.

FIG. 9.—GOVERNMENT SALMON HATCHERY, AFOGNAK LAKE.

HATCHERIES.

EXTENT OF OPERATIONS.

Four hatcheries, exclusive of Territorial plants, were operated in Alaska in 1921, two of which belong to the United States and two to private owners. The Federal stations are located at Afognak Lake, on Afognak Island, and at McDonald Lake, on the mainland of southeast Alaska near Yes Bay. The private hatcheries are located at Loring and Quadra in southeast Alaska, and are owned, respectively, by the Alaska Packers Association and the Northwestern Fisheries Co. The total number of red-salmon eggs collected at these four hatcheries in 1921 was 128,200,000, which is an increase of 28,210,000 over the collections of 1920. This increase was entirely due to the resumption of fish-cultural work at the McDonald Lake hatchery, as the take of eggs at the other hatcheries was less than in 1920.

Operations of Federal and private hatcheries in Alaska in 1921.

Station.	Red or sockeye salmon.		
	Eggs taken in 1920.	Salmon liberated in 1920-21.	Eggs taken in 1921.
McDonald Lake		[1] 4,025,000	51,000,000
Afognak Lake	[2] 62,300,000	47,808,000	53,835,000
Fortmann	18,240,000	17,375,000	13,380,000
Quadra	19,450,000	18,913,000	9,985,000
Total	99,990,000	88,121,000	128,200,000

[1] Hatched from eggs received from Afognak.
[2] 5,000,000 eyed eggs shipped to McDonald Lake hatchery, 2,340,500 to the Federal hatchery at Quinault, Wash., and, 3,000,000 to the State hatchery at Bonneville, Oreg.

HATCHERY REBATES.

The Federal fishery law of Alaska, approved June 26, 1906, provides that the owners of privately operated hatcheries shall be exempt from the payment of all taxes and license fees on their catch and pack of salmon at the rate of 40 cents per 1,000 red or king salmon fry liberated.

Rebates credited to private salmon hatcheries, fiscal year ended June 30, 1921.

Owner.	Location.	Red-salmon fry liberated.	Rebate due.
Alaska Packers Association	Naha Stream	17,375,000	$6,950.00
Northwestern Fisheries Co	Hugh Smith Lake	18,913,000	7,565.20
Total		36,288,000	14,515.20

HATCHERY OPERATIONS.

M'DONALD LAKE.

No salmon eggs were taken at McDonald Lake hatchery in 1920 owing to the work of renewing the water-supply pipe line, which was

not completed until after the close of the spawning season. Subsequently a shipment of 5,000,000 eyed red-salmon eggs was made from Afognak, from which 4,025,000 young salmon were produced and liberated in McDonald Lake. In 1921 the collection of red-salmon eggs aggregated 51,000,000. The egg-taking season ended September 27.

AFOGNAK.

From the collection of 62,300,000 red-salmon eggs obtained at Afognak in 1920 shipments of 5,000,000 and 2,340,500 eyed eggs were made, respectively, to the bureau's stations at McDonald Lake, southeast Alaska, and at Quinault, Wash., and 3,000,000 eyed eggs were shipped to the Oregon State hatchery at Bonneville. Out of the remaining 51,959,500 there were liberated 47,808,000 fry and fingerlings in Afognak Lake and tributaries. The loss of eggs and fry was 6.66 per cent. In the season of 1921 a total of 53,835,000 red-salmon eggs was collected. The run of salmon was good, and a larger take of eggs might have been made had not high water interrupted operations. The season opened in July and closed September 20.

FORTMANN.

The Fortmann hatchery of the Alaska Packers Association on Heckman Lake, Revillagigedo Island, liberated 17,375,000 young red salmon in Naha stream and lakes, out of 18,240,000 eggs collected in 1920. The loss of eggs was 4.74 per cent. In addition 345,000 humpback-salmon fry were hatched and planted in the same water system. Egg taking in 1921 began August 26 and ended November 21. In that period 13,380,000 red and 900,000 humpback salmon eggs were collected.

QUADRA.

The hatchery of the Northwestern Fisheries Co., on Hugh Smith Lake, produced and released 18,913,000 red-salmon fry out of a total collection of 19,450,000 eggs in 1920. The loss was 2.7 per cent. Spawn taking in 1921 began in August and ended November 14. In that time 9,985,000 red-salmon eggs were taken.

JUNEAU AND CORDOVA.

The Alaska Territorial Fish Commission continued fish-cultural work in the Juneau field during 1921 by collecting 6,300,000 coho and humpback salmon eggs. Of this number the commission reports that 5,300,000 were coho-salmon eggs, of which 1,000,000 were planted as eyed eggs and 4,050,000 were hatched and liberated as fry. The reported loss was 250,000 eggs and fry, or approximately 4.71 per cent. The remaining 1,000,000 eggs of the total collection were taken from humpback salmon. Out of this lot 500,000 fry were produced and distributed, 450,000 were planted as eyed eggs, and 50,000, or 5 per cent, were lost. Plants of eggs and fry were made in Baranof Lake, at Warm Springs Bay, and in the streams of Admiralty and Douglas Islands and of the mainland near Juneau.

Fish-cultural work was also inaugurated at Eyak Lake, near Cordova, by the construction of a battery of troughs for use as an eyeing

station. Red salmon exclusively were handled in this field. The collection of eggs aggregated 4,800,000, of which 4,600,000 were fertilized and planted. The loss was 200,000, or approximately 4 per cent. In the aggregate the commission collected 11,100,000 salmon eggs of all species. In 1921 it distributed in Alaskan waters12,400,000 fry and fertilized eggs, of which 1,900,000 were fry produced from eggs obtained in 1920. At the end of the year 100,000 coho fry were being held in the Juneau hatchery.

GENERAL STATISTICS OF THE FISHERIES.

The total active investment in the fisheries of Alaska in 1921 was $39,001,096, or $31,985,125 less than in 1920, which is largely accounted for by the elimination of the value of all inoperative canneries. The investment in the salmon industry alone amounted to $34,490,149, or approximately 88 per cent of the total investments. Employment was given to 15,070 persons, or 12,412 less than in 1920. The total value of the products in 1921 was $24,086,867, or $17,405,257 less than in 1920.

Summary of investments in the Alaska fisheries in 1921.

Industries.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Salmon canning	$8,637,938	$7,606,825	$17,001,529	$33,246,292
Salmon mild curing	613,516			613,516
Salmon pickling		62,205	371,790	433,995
Salmon, fresh	55,027			55,027
Salmon by-products	141,319			141,319
Halibut fishery	1,835,257			1,835,257
Herring fishery	377,538	1,109,014	25,477	1,512,029
Cod fishery		781,665		781,665
Shrimp fishery	147,814			147,814
Crab fishery	43,848			43,848
Whale fishery		190,334		190,334
Total	11,852,257	9,750,043	17,398,796	39,001,096

Summary of persons engaged in the Alaska fisheries in 1921.

Races.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Whites	2,085	1,982	4,166	8,233
Natives	1,595	777	421	2,793
Chinese	114	225	558	897
Japanese	314	247	87	648
Filipinos	140	100	717	957
Mexicans	14	130	1,229	1,373
Negroes	13	4	93	110
Miscellaneous	8	21	30	59
Total	4,283	3,486	7,301	15,070

Summary of products of the Alaska fisheries in 1921.

Products.	Quantity.	Value.
Salmon:		
Canned ... cases..	2,596,826	$19,632,741
Mild cured ... pounds..	2,814,800	608,218
Pickled ... do....	2,016,400	179,414
Frozen ... do....	1,506,074	127,442
Fresh ... do....	9,103,104	418,265
Dried and smoked ... do....	18,533	2,479
Fertilizer ... do....	464,000	13,920
Oil ... gallons..	15,010	4,102
Halibut:		
Fresh ... pounds..	9,575,287	910,375
Frozen ... do....	7,599,097	565,915
Pickled ... do....	100	10
Cheeks ... do....	1,790	150
Herring:		
Fresh for bait ... do....	1,660,048	16,600
Frozen for bait ... do....	626,000	5,880
Pickled for bait ... do....	380,000	4,800
Pickled, Scotch cure ... do....	14,523,441	838,335
Pickled, Norwegian cure ... do....	406,250	20,433
Fertilizer ... do....	892,000	26,760
Oil ... gallons..	84,938	21,236
Cod:		
Dry-salted ... pounds..	3,510,660	331,374
Pickled ... do....	1,276,711	125,896
Stockfish ... do....	460	50
Whale oil ... gallons..	57,000	19,950
Trout:		
Fresh ... pounds..	113,963	16,505
Frozen ... do....	15,741	2,135
Pickled ... do....	3,800	285
Clams ... cases..	1,420	9,940
Sablefish ... pounds..	392,767	17,985
Red rockfish ... do....	12,658	362
Smelts ... do....	2,000	50
Shrimps ... do....	344,986	132,077
Crabs:		
Canned ... cases..	4,075	32,780
Fresh ... pounds..	2,400	400
Total ...	....	[1] 24,086,867

[1] These figures represent the value of the manufactured product. It is estimated that the value of the catch to the fishermen is approximately $7,000,000.

SALMON INDUSTRY.

In so far as the salmon industry of Alaska is concerned, the operations of 1921 were conspicuous in at least two particulars, namely, (*a*) the marked reduction of activities in the southeast and central districts, and (*b*) the increased production of red salmon in the western district over the two years immediately preceding.

The chief cause of lessened operations in southeast and central Alaska, where a large part of the pack each year consists of the cheaper grades of salmon, was no doubt the unsatisfactory market for such products, brought about by a surplus of canned humpback and chum salmon from the packs of 1919 and 1920; also, the anticipated light run of salmon in those districts was an important factor in discouraging financial outlays for unpromising results. This suspension of operations by several packing companies may ultimately be beneficial to the fisheries, as a larger escapement of spawning salmon resulted than would otherwise have been the case.

In western Alaska the run of red salmon increased and the pack was larger than in 1919 and 1920, notwithstanding the voluntary limitation of operations by the companies established in that district.

SALMON CATCH AND APPARATUS.

In 1921 there were used in the salmon fisheries of Alaska 95 beach seines, aggregating 13,488 fathoms, and 118 purse seines, aggregating 21,575 fathoms, a total of 213 seines, or 35,063 fathoms. This is a decrease of 499 seines, or 82,048 fathoms, from the number reported in 1920. Southeast Alaska is credited with 138 seines, having a total length of 20,525 fathoms; central Alaska, with 59 seines, having a total length of 9,908 fathoms, and western Alaska, with 16 seines, having a total length of 4,630 fathoms.

Statistics show that 3,235 gill nets, aggregating 375,320 fathoms, were operated in 1921. Of this number 230 nets, or 43,850 fathoms of webbing, were used in southeast Alaska; 672 nets, or 47,950 fathoms, in central Alaska; and 2,333 nets, or 283,520 fathoms, in western Alaska. This is a decrease of 1,362 gill nets, or 99,894 fathoms, from the 4,597 nets, or 475,214 fathoms, employed in 1920.

The total number of traps used in the salmon industry in 1921 was 180, of which 127 were driven and 53 floating. As compared with 1920, when 653 traps were operated, this is a decrease of 473. Southeast Alaska is credited with 62 driven and 51 floating traps, decreases, respectively, of 225 and 146; central Alaska, with 59 driven and 2 floating traps, decreases, respectively, of 91 and 9; and western Alaska, with 6 driven traps, a decrease of 2.

Considering the total catch of salmon by apparatus, the approximate per cent taken by the three important kinds of apparatus was as follows: Seines 18, gill nets 47, and traps 32. In 1920 seines took $26\frac{2}{3}$ per cent, gill nets 20 per cent, and traps 42 per cent.

Percentage of salmon caught in each Alaska district, by principal forms of apparatus.

Apparatus.	Southeast Alaska.		Central Alaska.		Western Alaska.	
	1920	1921	1920	1921	1920	1921
Seines	30	32	34	25	6	6
Gill nets	2	5	7	10	86	90
Traps	66	56	59	63	8	3

The production of salmon in Alaska in 1921 was 37,905,591, as compared with 65,080,539, in 1920, a decrease of 27,174,948, or approximately 41 per cent. The decrease in southeast Alaska was 21,244,129, and in central Alaska 11,644,986. In western Alaska there was an increase of 5,714,167. The catch in Alaska as a whole compared with that of 1920 shows that cohos decreased 708,654, chums 7,476,776, and humpbacks 24,955,793, and that kings increased 50,909, and reds 5,915,366. This is the smallest catch of salmon in southeast Alaska in 17 years, or since 1904.

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Salmon taken in 1921, by apparatus and species, for each geographic section of Alaska.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Seines:				
Coho, or silver	236,165	32,190	....	268,355
Chum, or keta	808,442	3,351	3,710	815,503
Humpback, or pink	2,063,941	55,915	....	2,099,856
King, or spring	7,477	658	5,973	14,108
Red, or sockeye	710,413	1,965,836	1,093,143	3,769,392
Total	3,826,438	2,037,950	1,102,826	6,967,214
Gill nets:				
Coho, or silver	187,102	5,970	85,564	278,636
Chum, or keta	21,722	63	444,455	466,240
Humpback, or pink	63,301	674	939	64,914
King, or spring	37,355	15,434	166,923	219,712
Red, or sockeye	288,578	779,460	15,666,571	16,734,609
Total	598,058	801,601	16,364,452	17,764,111
Pound nets:				
Coho, or silver	366,007	52,126	....	418,133
Chum, or keta	941,466	367,246	44,446	1,353,158
Humpback, or pink	4,865,850	126,156	....	4,992,006
King, or spring	13,710	21,996	8,101	43,807
Red, or sockeye	457,844	4,455,630	601,709	5,515,183
Total	6,644,877	5,023,154	654,256	12,322,287
Lines:				
Coho, or silver	216,704	....	....	216,704
Humpback, or pink	42	....	....	42
King, or spring	546,392	....	....	546,392
Red, or sockeye	20,000	....	....	20,000
Total	783,138	....	....	783,138
Dip nets:				
Coho, or silver	....	377	....	377
King, or spring	....	2,157	....	2,157
Red, or sockeye	....	64,107	....	64,107
Total	....	66,641	....	66,641
Wheels:				
Chum, or keta	....	....	2,000	2,000
King, or spring	....	....	200	200
Total	....	....	2,200	2,200
Total:				
Coho, or silver	1,005,978	90,663	85,564	1,182,205
Chum, or keta	1,771,630	370,660	494,611	2,636,901
Humpback, or pink	6,993,134	162,745	939	7,156,818
King, or spring	604,934	40,245	181,197	826,376
Red, or sockeye	1,476,835	7,265,033	17,361,423	26,103,291
Grand total	11,852,511	7,929,346	18,123,734	37,905,591

SALMON CANNING.

CHANGES IN CANNERIES.

Several changes occurred in the ownership or operation of canneries in Alaska in 1921. P. E. Harris & Co. purchased the cannery of the Sockeye Salmon Co. on Isanotski Strait. The cannery of the Valdez Packing Co., at Valdez, was leased to Joseph Emil. The Mitkof Island Packing Co. was incorporated to take over and operate the cannery of the Petersburg Packing Corporation at Petersburg. The Admiralty Packing Co. operated the cannery at Pybus Bay, formerly listed under the name of the Pybus Bay Fish & Packing Co. Delong & Wolf leased the cannery of the Sitka Packing Co., at Sitka. The

FIG. 10.—UNLOADING SALMON FROM SCOW AT CANNERY, BRISTOL BAY.

FIG. 11.—CANNERY SHIP, SALMON SCOW, AND TENDER, BRISTOL BAY.

cannery of the Union Bay Fisheries Co., at Union Bay, was sold under a foreclosure to the G. W. Hume Co., the chief creditor. The Anacortes Fisheries Co. was dissolved, and its canneries were transferred to the Northwestern Fisheries Co., a subsidiary of the Booth Fisheries Co. The cannery of the Columbia Salmon Co., at Craig, was taken over and operated by the Sea-Coast Packing Co. as a mild-curing station.

NEW CANNERIES.

Two new canneries were built and operated in 1921, one at Coppermount, in southeast Alaska, by the Hetta Packing Co., and one at Uzinki, in central Alaska, by the Katmai Packing Co. A few cases of salmon were also packed on the Yukon delta by W. F. O'Connor and at Pybus Bay by Fred Patten. The Phoenix Packing Co. reopened its plant at Herendeen Bay. The Mountain Point Packing Co., whose cannery at Mountain Point was destroyed by fire in 1920, rebuilt and packed in 1921.

CANNERIES NOT OPERATED.

Sixty-eight salmon canneries remained closed during the year and two floating plants engaged in other operations. Of this number 51, including 2 floaters, were located in southeastern Alaska, 14 in central Alaska, and 3 in western Alaska. The floating cannery of Ainsworth & Dunn was returned to Puget Sound; that of the Cape Flattery Fisheries Co. and that of the Olympic Fisheries Co. were operated in the shrimp and crab industry. The canneries that were idle during the year were owned and located as follows:

Alaska Fish Co.	Waterfall.
Alaska Packers Association	Loring. Wrangell. Kenai.
Alaska Pacific Fisheries	Chomley. Yes Bay.
Alaska Salmon & Herring Packers	Tyee.
Alaska Sanitary Packing Co	Cape Fanshaw.
American Packing Co	Juneau.
Astoria & Puget Sound Canning Co	Excursion Inlet.
Auk Bay Salmon Canning Co	Auk Bay.
Baranof Packing Co	Red Bluff Bay.
F. C. Barnes Co	Lake Bay.
Beauclaire Packing Co	Port Beauclerc.
Beegle Packing Co	Ketchikan.
Burnett Inlet Packing Co	Burnett Inlet.
Cape Fanshaw Fish & Packing Co. (Inc.)	Cape Fanshaw.
Columbia Salmon Co	Tenakee.
Deep Sea Salmon Co	Ford Arm.
Fidalgo Island Packing Co	Ketchikan. Pillar Bay.
Hood Bay Packing Co	Hood Bay.
Hoonah Packing Co	Bering River. Gambier Bay Hoonah.
Karheen Packing Co	Karheen.
Ketchikan Packing Co	Ketchikan.
Marathon Fishing & Packing Co	Cape Fanshaw.
Mutual Packing Co	Floating.
Mount Baker Packing Co	Floating.
Northern Packing Co	Juneau.

Northwestern Fisheries Co.	Dundas Bay. Hunter Bay. Kasaan. Kenai. Orca. Quadra. Roe Point. Santa Ana. Seldovia. Shakan.
Noyes Island Packing Co.	Steamboat Bay.
Pacific American Fisheries.	Excursion Inlet. King Cove.
Petersburg Packing Corporation.	Washington Bay.
Point Warde Packing Co.	Point Warde.
Pure Food Fish Co.	Ketchikan.
Pyramid Packing Co.	Sitka.
Revilla Packing Co.	Ketchikan.
Sanborn Cutting Co.	Keke.
Southern Alaska Canning Co.	Big Port Walter. Quadra. Rose Inlet.
Starr-Collinson Packing Co.	Moira Sound.
E. R. Strand.	Wrangell Narrows.
Todd Packing Co.	Todd.
Union Bay Fisheries Co.	Union Bay.
Canoe Pass Packing Co.	Shepard Point.
Central Alaska Fisheries.	Drier Bay.
Copper River Packing Co.	McClure Bay.
Kenai Packing Co.	Drier Bay.
King Salmon Fisheries Co.	Unakwik Inlet.
Moore Packing Co.	Orca Inlet.
Shumagin Packing Co.	Squaw Harbor.
Seldovia Canning Co.	Seldovia.
Alaska Portland Packers Association.	Nushagak Bay.
Nelson Lagoon Packing Co.	Nelson Lagoon.
Midnight Sun Packing Co.	Kotzebue Sound.

TOTAL CANNERIES OPERATED.

Eighty-three salmon canneries were operated in Alaska in 1921. The division by districts is as follows: Southeast Alaska, 30; central Alaska, 25; and western Alaska, 28. This is a decrease of 63 from the number operated in 1920.

Companies canning salmon in Alaska, number and location of canneries operated, and number of pound nets owned by each, 1921.

[New canneries indicated by (*)]

Company.	Canneries.		Pound nets.		
	Number.	Location.	Driven.	Floating.	Total.
SOUTHEAST ALASKA.					
Admiralty Packing Co.	1	Pybus Bay			
Alaska Herring & Sardine Co.	1	Port Walter	2	17	19
Alaska Pacific Fisheries	1	Tee Harbor	3	2	5
Alaska Sanitary Packing Co.	1	Wrangell	1		1
Alaska Union Fisheries (Inc.)	1	Port Conclusion			
Annette Island Packing Co.	1	Metlakatla	4		4
John L. Carlson & Co.	1	Auk Bay		5	5
Chilkat Packing Co.	1	Haines			
Deep Sea Salmon Co.	1	Port Althorp		5	5
Delong & Wolf	1	Sitka			
Douglas Island Packing Co.	1	Douglas			

Companies canning salmon in Alaska, number and location of canneries operated, and number of pound nets owned by each, 1921—Continued.

Company.	Canneries.		Pound nets.		
	Number.	Location.	Driven.	Floating.	Total.
George Inlet Packing Co	1	George Inlet	1		1
Haines Packing Co	1	Letinkof Cove			
P. E. Harris & Co	1	Hawk Inlet	1	4	5
Hetta Packing Co	1	Coppermount*			
Hidden Inlet Canning Co	1	Hood Bay			
G. W. Hume Co	1	Scow Bay	1		1
Libby, McNeill & Libby	2	Taku Harbor	10		10
		Yakutat			
Mitkof Island Packing Co	1	Petersburg	8		8
Mountain Point Packing Co	1	Wrangell Narrows	1	1	2
Geo. T. Myers & Co	1	Chatham	4	4	8
North Pacific Trading & Packing Co	1	Klawak		2	2
Pavlof Harbor Packing Co	1	Pavlof Harbor			
J. L. Smiley & Co	1	Ketchikan	3	1	4
Standard Salmon Packers (Inc.)	1	Tenakee			
Sunny Point Packing Co	1	Ketchikan	1		1
Swift Arthur Crosby Co	1	Heceta Island	1	1	2
Thlinket Packing Corporation	1	Funter Bay	5	6	11
Ward's Cove Packing Co	1	Ward Cove	2		2
CENTRAL ALASKA.					
Alaska Packers Association	3	Olga Bay	6	1	7
		Chignik	3		3
		Larsen Bay			
Alaska Sea Food Co	1	Point Whitshed	1		1
Alitak Packing Co	1	Lazy Bay	4		4
Arctic Packing Co	1	English Bay			
Bainbridge Fisheries Co	1	Evans Island	1		1
Carlisle Packing Co	1	Cordova			
Columbia River Packers' Association	1	Chignik	3		3
Joseph Emil	1	Valdez			
Eyak River Packing Co	1	Eyak River			
Fidalgo Island Packing Co	1	Port Graham	7		7
P. E. Harris & Co	1	Isanotski Strait	3		3
Hayes-Graham Fish Co	1	(Floating)			
Hillery-Scott Co	1	Cordova			
Kadiak Fisheries Co	1	Kodiak			
Katmai Packing Co	1	Uzinki*			
Libby, McNeill & Libby	1	Kenai	13		13
F. H. Madden	1	Abercrombie			
Northwestern Fisheries Co	2	Chignik	3		3
		Uyak			
Pacific American Fisheries	1	Ikatan	10		10
Pioneer Packing Co	1	Cordova	2	1	3
San Juan Fishing & Packing Co	1	Seward	1		1
Surf Packing Co	1	Chisik Island	2		2
WESTERN ALASKA.					
Alaska Packers Association	9	Kvichak River (2)			
		Naknek River (3)			
		Nushagak River (2)			
		Ugaguk River			
		Ugashik River			
Alaska-Portland Packers' Association	1	Naknek			
Alaska Salmon Co	1	Wood River			
Bristol Bay Packing Co	1	Kvichak River			
Carlisle Packing Co	1	Kwiguk Slough			
Columbia River Packers' Association	1	Nushagak Bay			
Everett Packing Co	1	Herendeen Bay			
Libby, McNeill & Libby	6	Ekuk			
		Kvichak Bay			
		Libbyville			
		Lockanok			
		Nushagak			
		Ugaguk River			
Naknek Packing Co	1	Naknek River			
Northwestern Fisheries Co	2	Naknek River			
		Nushagak			
Pacific American Fisheries	1	Port Moller	6		6
Phoenix Packing Co	1	Herendeen Bay			
Red Salmon Canning Co	2	Naknek River			
		Ugashik River			

LOSSES AND DISASTERS.

Losses of property in the salmon industry aggregated $401,452, of which amount $350,000 represented the value of the Kenai cannery of Libby, McNeill & Libby, which was destroyed by fire on June 21. Fishing gear and small boats, valued at $14,050, were lost in southeast Alaska. Central Alaska, exclusive of the Kenai plant, reported a loss in gear and boats of $4,235. The loss of gear, boats, supplies, and damage to buildings totaled $33,177.

Eleven people were drowned, six reported from western Alaska and five from southeast Alaska. Of the total number, six were fishermen, three shoresmen, and two transporters.

STATISTICS.

The total number of salmon canneries operated in Alaska in 1921 was 83, or 63 less than the number in 1920. By this showing the total active investment was $33,246,292, or $29,304,335 less than in 1920. The falling off by districts is as follows: Southeast Alaska, $21,515,860; central Alaska, $6,452,127; and western Alaska, $1,336,448. Employment was given to 12,986 persons, or 11,437 less than in 1920. The decrease in the number of whites was 6,813, natives 1,011, Chinese 1,481, Japanese 781, Filipinos 630, Mexicans 295, Negroes 199, and miscellaneous 226.

A total of 2,596,826 cases of salmon was packed in 1921, valued at $19,632,744. As compared with 1920, this is a decrease in produstion of 1,832,637 cases, or approximately 41 per cent, and in value of $15,970,056, or approximately 45 per cent. This decrease may be attributed chiefly to the fact than 68 canneries were not operated, the majority of which were located in southeast Alaska, where the decline was heaviest. Most of the canneries in that district were dependent on the run of humpback salmon for their packs, but the unsatisfactory market for this species undoubtedly weighed heavily against operations in 1921. By this reduction in fishing, particularly in southeast Alaska, a larger escapement of salmon unquestionably resulted which should have a beneficial effect upon the runs in the years to come.

The pack of canned salmon in 1921 was less than that of 1920 by 1,832,637 cases. Southeast Alaska fell off 1,421,940 cases and central Alaska 694,349 cases, but western Alaska increased 283,652 cases. This is the smallest production of canned salmon in Alaska since 1907. Comparing the total pack by species in 1920 and 1921, the following results are noted: Cohos decreased from 192,085 cases to 106,555, a decline of 85,530 cases; chums, from 1,033,517 to 255,495, a decline of 778,022; humpbacks from 1,593,120 to 423,984, a decline of 1,169,136; kings from 110,003 to 44,994, a decline of 65,009; and reds increased from 1,500,738 cases to 1,765,798, a gain of 265,060 cases.

Investment in the Alaska salmon-canning industry in 1921.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Canneries operated	30	$2,883,889	25	$2,058,810	28	$4,856,122	83	$9,807,821
Working capital		2,805,006		2,314,855		3,985,331		9,105,192
Wages paid		993,276		1,400,839		3,667,365		6,061,480
Vessels:								
Power, over 5 tons	106	759,189	61	602,215	78	1,623,926	245	2,985,330
Net tonnage	2,146		1,625		7,857		11,628	
Sailing			5	295,119	31	1,192,240	36	1,487,359
Net tonnage			8,675		45,383		54,058	
Barges	2	15,166					2	15,166
Net tonnage	1,654						1,654	
Launches, under tonnage	36	45,285	62	71,883	34	92,101	132	209,269
Boats, row and sail	517	67,825	646	94,605	1,308	543,046	2,471	705,476
Lighters, scows, and houseboats	141	152,764	163	148,068	183	464,492	487	765,324
Pile drivers and pile pullers	30	226,947	28	135,679	21	48,262	79	410,888
Apparatus:								
Beach seines	36	18,125	52	28,554			88	46,679
Fathoms	3,960		8,793				12,753	
Purse seines	95	53,715	6	3,050	16	26,000	117	82,765
Fathoms	15,860		1,015		4,630		21,505	
Gill nets	223	60,170	665	70,631	2,169	463,644	3,057	594,445
Fathoms	42,150		47,250		267,540		356,940	
Pound nets, driven	60	421,404	58	380,186	6	30,000	124	831,590
Pound nets, floating	51	135,177	2	1,795			53	136,972
Dip nets			165	536			165	536
Total		8,637,938		7,606,825		17,001,529		33,246,292

Persons engaged in the Alaska salmon-canning industry in 1921.

Occupations and races.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Fishermen:				
Whites	401	685	2,358	3,444
Natives	585	230	88	903
Miscellaneous [1]	4		1	5
Total	990	915	2,447	4,352
Shoresmen:				
Whites	598	512	1,467	2,577
Natives	797	488	271	1,556
Chinese	104	225	558	887
Japanese	277	247	87	611
Filipinos	140	100	717	957
Mexicans	13	130	1,214	1,357
Negroes	12	3	93	108
Miscellaneous [1]	3	20	28	51
Total	1,944	1,725	4,435	8,104
Transporters:				
Whites	187	143	159	489
Natives	9	23	6	38
Miscellaneous [1]	1	1	1	3
Total	197	167	166	530
Total:				
Whites	1,186	1,340	3,984	6,510
Natives	1,391	741	365	2,497
Chinese	104	225	558	887
Japanese	277	247	87	611
Filipinos	140	100	717	957
Mexicans	13	130	1,214	1,357
Negroes	12	3	93	108
Miscellaneous [1]	8	21	30	59
Grand total	3,131	2,807	7,048	12,986

[1] Koreans, Porto Ricans, Kanakas, etc.

Output and value of canned salmon in Alaska in 1921. [1]

Product.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Cases.	Value.	Cases.	Value.	Cases.	Value.	Cases.	Value.
Coho, or silver:								
½-pound flat	4,004	$31,846	80	$640			4,084	$32,486
1-pound flat	7,918	51,710					7,918	51,710
1-pound tall	78,880	431,666	9,630	50,299	6,043	$33,979	94,553	515,944
Total	90,802	515,222	9,710	50,939	6,043	33,979	106,555	600,140
Chum, or keta:								
½-pound flat	608	3,183					608	3,183
1-pound tall	180,839	650,134	34,571	127,508	39,477	161,700	254,887	939,342
Total	181,447	653,317	34,571	127,508	39,477	161,700	255,495	942,525
Humpback, or pink:								
½-pound flat	1,292	8,774					1,292	8,774
1-pound tall	415,489	1,750,743	7,147	29,018	56	243	422,692	1,780,004
Total	416,781	1,759,517	7,147	29,018	56	243	423,984	1,788,778
King, or spring:								
½-pound flat	2,396	37,840	1,665	24,588			4,061	62,428
1-pound flat	2,950	32,450	560	7,840	15,682	205,376	19,192	245,666
1-pound tall	3,763	25,396	6,404	47,843	11,574	78,564	21,741	151,803
Total	9,109	95,686	8,629	80,271	27,256	283,940	44,994	459,897
Red, or sockeye:								
½-pound flat	17,958	279,429	29,970	440,769	12,903	90,179	60,831	810,377
1-pound flat	32,649	407,929	21,985	253,781	16,474	169,241	71,108	830,951
1-pound tall	54,325	453,350	531,087	4,599,963	1,048,447	9,146,763	1,633,859	14,200,076
Total	104,932	1,140,708	583,042	5,294,513	1,077,824	9,406,183	1,765,798	15,841,404
Grand total	803,071	4,164,450	643,099	5,582,249	1,150,656	9,886,045	2,596,826	19,632,744

[1] Cases containing ½-pound cans have been reduced one-half in number, and thus, for the purpose of affording fair comparison, all are put upon the basis of 48 1-pound cans per case.

Output of canned salmon in Alaska, 1915 to 1921. [1]

Product.	1915	1916	1917	1918	1919	1920	1921	Total.
	Cases.	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*
Coho, or silver:								
½-pound flat	2,050	13,145	30,412	26,238	9,719	8,915	4,084	94,563
1-pound flat	2,338	8,191	362	12,786	10,438	10,746	7,918	52,779
1-pound tall	119,880	240,573	162,457	179,934	212,713	172,424	94,553	1,182,534
Total	124,268	261,909	193,231	218,958	232,870	192,085	106,555	1,329,876
Chum, or keta:								
½-pound flat		1,423	26,760	3,559	3,981	53	608	36,384
1-pound flat	317		2,530	2,996		46,167		52,010
1-pound tall	479,629	722,692	877,457	1,358,405	1,361,582	987,297	254,887	6,041,959
Total	479,946	724,115	906,747	1,364,960	1,365,563	1,033,517	255,495	6,130,353
Humpback, or pink:								
½-pound flat	4,325	41,491	91,403	63,557	28,185	18,970	1,292	249,223
1-pound flat	3,508	14,796	6,014	20,215	7,553	76,017		128,103
1-pound tall	1,867,683	1,681,506	2,199,559	2,355,182	1,575,870	1,498,133	422,692	11,600,625
Total	1,875,516	1,737,793	2,296,976	2,438,954	1,611,608	1,593,120	423,984	11,977,951
King, or spring:								
½-pound flat	2,404	2,617	12,973	6,000	7,584	10,196	4,061	45,835
1-pound flat	3,755	3,804	5,133	5,267	11,532	18,319	19,192	67,002
1-pound tall	82,092	59,452	43,845	37,959	76,870	81,488	21,741	403,447
Total	88,251	65,873	61,951	49,226	95,986	110,003	44,994	516,284

[1] The number of cases shown has been put upon the common basis of 48 one-pound cans per case.

Output of canned salmon in Alaska, 1915 to 1921—Continued.

Product.	1915	1916	1917	1918	1919	1920	1921	Total.
Red, or sockeye:	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*
½-pound flat	52,033	81,565	124,309	137,008	122,236	101,716	60,831	679,698
1-pound flat	112,847	86,395	89,612	151,864	110,491	120,147	71,108	742,464
1-pound tall	1,765,139	1,936,971	2,274,460	2,244,865	1,044,934	1,278,875	1,633,859	12,179,103
1½-pound nominals	2,293							2,293
2-pound nominals		6,006						6,006
Total	1,932,312	2,110,937	2,488,381	2,533,737	1,277,661	1,500,738	1,765,798	13,609,564
Grand total	4,500,293	4,900,627	5,947,286	6,665,835	4,583,688	4,429,463	2,596,826	33,564,018

Average annual price per case of 48 one-pound cans of salmon, 1911 to 1921.

Product.	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
Coho, or silver	$5.67	$4.44	$3.45	$4.39	$4.31	$5.34	$8.76	$9.15	$11.27	$9.13	$5.63
Chum, or keta	3.72	2.37	2.21	3.37	2.59	3.34	6.14	6.27	6.82	4.19	3.68
Humpback, or pink	3.94	2.55	2.58	3.50	2.78	3.64	6.44	6.58	8.35	5.47	4.21
King, or spring	6.48	5.37	4.04	5.01	4.63	5.36	10.40	9.85	13.13	10.97	10.22
Red, or sockeye	6.33	5.45	4.54	5.58	5.82	6.04	9.48	9.44	12.98	13.05	8.96

MILD CURING OF SALMON.

The salmon mild-curing industry of Alaska is influenced largely by market conditions, perhaps to a greater extent than other branches of the salmon industry. Mild-cured salmon constitute a very perishable product, which necessitates careful handling and refrigeration or easy access to markets. For these reasons the industry is centered chiefly in southeast Alaska, which produces approximately 90 per cent of the pack. Both king and coho salmon are mild cured, and the bulk of the catch is made by trollers, who are not interested in the curing end of the business. This industry in 1921 showed an investment of $613,516 and gave employment to 449 persons, exclusive of independent trollers, of which there were estimated to be 6,000 in southeast Alaska. A total of 3,556 tierces of mild-cured salmon, valued at $608,218, was produced in 1921, of which 3,530 tierces were king salmon and 26 cohos. Corresponding figures for 1920 were 357 persons employed and 2,295 tierces of salmon, all kings, valued at $364,219.

Investment, persons engaged, and products of Alaska salmon mild-curing industry in 1921.

Items.	Number.	Value.
INVESTMENT.		
Plants	7	$147,867
Operating capital		351,261
Vessels:		
Power, over 5 tons	12	65,700
Net tonnage	211	
Barges	3	19,507
Launches under 5 tons	6	6,382
Other boats and skiffs	21	2,780
Lighters	3	8,000
Apparatus:		
Gill nets (2,230 fathoms)	48	6,315
Pound nets, driven	1	4,000
Lines	853	1,704
Total		613,516
PERSONS ENGAGED.		
Fishermen:		
Whites	323	
Natives	26	
Total	349	

Items.	Number.	Value.
PERSONS ENGAGED—con't.		
Shoresmen:		
Whites	60	
Natives	12	
Total	72	
Transporters:		
Whites	26	
Natives	2	
Total	28	
Grand total	449	
PRODUCTS (POUNDS).		
Coho, or silver[1]	20,800	$1,780
King, or spring[2]	2,794,000	606,438
Total	2,814,800	608,218

[1] 26 tierces.

[2] 3,530 tierces.

SALMON PICKLING.

Salmon pickling in 1921 was confined largely to western Alaska, as out of a total investment of $433,995 that district was credited with $371,790, the remaining $62,205 representing the investment in central Alaska. This is a gain of $135,314 over the amount invested in 1920. The production of pickled salmon was 10,082 barrels, valued at $179,414, an increase over that of 1920 of 5,260 barrels, or approximately 109 per cent. The value of the products was $74,541 greater than in 1920, a gain of approximately 71 per cent. This industry gave employment to 195 persons, as compared with 157 in 1920. One fisherman was drowned, and apparatus valued at $330 was lost.

Investment, persons engaged, and products of Alaska salmon-pickling industry in 1921, by districts.

Items.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENT.								
Salteries			2	$43,500	7	$85,867	9	$129,367
Operating capital				9,205		140,806		150,011
Vessels:								
Power, over 5 tons					4	58,206	4	58,206
Net tonnage					261		261	
Sailing					2	20,000	2	20,000
Net tonnage					955		955	
Launches			4	6,000	9	31,106	12	37,106
Boats, gill net and row					52	14,655	52	14,655
Lighters and pile drivers			2	1,200	7	6,900	9	8,100
Apparatus:								
Haul seines			1	100			1	100
Fathoms			100				100	
Gill nets			7	1,400	118	13,950	125	15,350
Fathoms			700		9,310		10,010	
Pound nets, driven			1	800			1	800
Wheels					2	300	2	300
Total				62,205		371,790		433,995
PERSONS ENGAGED.								
Fishermen:								
Whites					62		62	
Natives					5		5	
Total					67		67	
Shoresmen:								
Whites			3		67		70	
Natives			13		18		31	
Mexicans					15		15	
Total			16		100		116	
Transporters: White			2		10		12	
Grand total			18		177		195	
PRODUCTS (BARRELS).[1]								
Coho, or silver	115	$1,624	83	1,120	8	120	206	2,864
Chum, or keta	183	1,443	5	50	103	1,558	291	3,051
Humpback, or pink	378	3,062	30	355			408	3,417
King, or spring			256	5,120	217	5,487	473	10,607
Red, or sockeye	486	9,574	571	10,654	7,647	139,247	8,704	159,475
Total	1,162	15,703	945	17,299	7,975	146,412	10,082	179,414

[1] Each barrel holds 200 pounds of fish.

FRESH SALMON.

The fresh-salmon trade in Alaska is centered in the southeast section of the Territory, where markets are more easily accessible than in the remoter regions of central and western Alaska. In 1921 part of this business went to Prince Rupert, British Columbia, due to the better price there for fresh salmon than was obtainable in Alaska ports. In various cases the fishermen made deliveries direct from the fishing ground. This industry shows an investment of $55,027 and a production of 9,103,104 pounds of salmon, valued at $418,265. In comparison with the output in 1920, this is an increase of 5,855,023 pounds in products and of $155,001 in value.

Investments, persons engaged, and products of the Alaska fresh-salmon industry in 1921.

Items.	Number.	Value.	Items.	Number.	Value.
INVESTMENT.			PERSONS ENGAGED.		
Operating capital		$21,542	Fishermen	3	
Floating equipment		21,805	Shoresmen	2	
Apparatus:			Transporters	15	
Haul seines	6	1,350			
Fathoms	635		Total	20	
Purse seines	1	100			
Fathoms	70		PRODUCTS (POUNDS).		
Gill nets	5	1,730	Coho, or silver	1,593,274	$67,077
Fathoms	1,500		Chum, or keta	876,895	17,089
Traps, pile	2	8,500	Humpback, or pink	1,586,543	37,286
Total		55,027	King, or spring	4,772,866	271,478
			Red, or sockeye	273,526	25,335
			Total	9,103,104	418,265

SALMON FREEZING.

Six companies reported productions of frozen salmon, five of which were located in southeast Alaska, while Waechter Bros. Co. froze approximately 20,000 pounds of king and chum salmon on the Yukon River. As all the operators of freezing plants were engaged chiefly in other fishery activities, there was no distinctive investment in this business. A total of 1,506,074 pounds of frozen salmon was produced in 1921, as compared with 1,916,595 pounds in 1920. The products were valued at $127,442, as compared with $161,143 in 1920.

Quantity and value of salmon frozen in Alaska in 1921, by species.

Species.	Pounds.	Value.
Coho, or silver	379,628	$22,787
Chum, or keta	38,307	1,947
King, or spring	1,038,128	98,708
Red, or sockeye	50,011	4,000
Total	1,506,074	127,442

DRYING AND SMOKING OF SALMON.

The only reported production of smoked salmon in 1921 was by the Juneau Cold Storage Co., which kippered 10,000 pounds of king salmon, valued at $1,500. According to customhouse records, 1,311

pounds of coho salmon, valued at $196; 6,000 pounds of chums, valued at $600; and 1,222 pounds of king salmon, valued at $183, were dried and smoked. The total quantity of dried and kippered salmon was 18,533 pounds, valued at $2,479. In western and central Alaska a considerable quantity of salmon is dried or smoked for local use, but no statistics of the number and kind of salmon thus utilized are available.

SALMON BY-PRODUCTS.

The Petersburg By-products Co., at Scow Bay, and the Alaska Reduction Co., at Hawk Inlet, were the only firms operating in Alaska in 1921 that utilized salmon offal and scrap fish in manufacturing oil and fertilizer. This industry shows an investment of $141,319, and it gave employment to 27 persons. The products were 232 tons of fertilizer, valued at $13,920, and 15,010 gallons of oil, valued at $4,102. Corresponding figures for 1920 were: Investment, $375,127; number of persons employed, 139; and products, 889 tons of fertilizer, valued at $88,382, and 39,052 gallons of oil, valued at $16,370. The value of the products in 1921 was $86,730 less than the value in 1920.

HALIBUT FISHERY.

No changes of special importance were noted in the halibut industry of Alaska in 1921. As usual, part of the catch on what are generally regarded as the halibut banks of Alaska was diverted to ports in British Columbia. The Pacific coast market for halibut is somewhat limited, and the bulk of the output is therefore shipped to eastern markets.

STATISTICAL SUMMARY.

The investment in the halibut industry in 1921 is given as $1,835,257, or $435,465 less than the amount reported in 1920. Employment was given to 452 persons, as against 768 in 1920. In arriving at the total investment and the number of persons employed it was necessary to include an estimate of the value of independent vessels making deliveries at Alaskan ports, together with the value of apparatus used and the number of fishermen on each vessel. The products of the halibut fishery entered through the ports of Alaska in 1921 were 17,176,274 pounds, valued at $1,476,450, as compared with 15,295,500 pounds, valued at $1,726,798, in 1920.

Investment, persons engaged, and products of Alaska halibut fishery in 1921.

Item.	Number.	Value.	Item.	Number.	Value.
INVESTMENT.			PERSONS ENGAGED.		
Vessels:			Whites	310	
Steam and gas	105	$1,113,500	Natives	132	
Net tonnage	2,373		Chinese	10	
Launches	1	500			
Scows	1	4,000	Total	452	
Apparatus		27,094			
Shore property		356,358	PRODUCTS (POUNDS)		
Cash capital		333,805			
			Fresh (including local)	9,575,287	$910,375
Total		1,835,257	Frozen	7,599,097	565,915
			Pickled	100	10
			Halibut cheeks	1,790	150
			Total	17,176,274	1,476,450

FIG. 12.—SALMON TRAP AND PURSE SEINE.

FIG. 13.—HALIBUT DORY COMING ALONGSIDE FISHING VESSEL, SOUTHEAST ALASKA.

HERRING FISHERY.

The most noteworthy developments in the herring industry of Alaska in 1921 were the augmented pack of Scotch-cured herring in the central district, the discontinuance of the canning of herring, and the greatly reduced production of herring oil and fertilizer and meal. The use of herring as bait in 1921 was apparently considerably less than in 1920. It is evident from the operations of 1921 that there is a growing demand in the United States for Alaska Scotch-cured herring, and that careful packers are able to find a ready market for their products.

STATISTICAL SUMMARY.

The Alaska herring industry is credited with an investment of $1,512,029, as compared with $1,396,612 in 1920. Employment was given to 445 persons. The value of all herring products was $934,044, as against $1,303,614 in 1920. Scotch-cured herring increased from 8,223,490 pounds in 1920 to 14,523,441 pounds in 1921, exceeding by approximately 5,000,000 pounds the pack of any previous year since this cure was introduced by the bureau. Losses in the herring industry aggregated $34,575, of which $27,805 represents the plant and equipment of the W. J. Inloch Packing Co., at Sawmill Bay, which was destroyed by fire early in the season.

Investment, persons engaged, and products of Alaska herring fishery in 1921.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENT.								
Plants operated	4	$123,880	8	$281,306	1	$11,000	13	$416,186
Operating capital		158,388		675,023		10,177		843,588
Vessels:								
Power, over 5 tons	5	72,450	17	76,500			22	148,950
Net tonnage	395		309				704	
Launches under 5 tons	1	300	5	9,200	1	1,500	7	11,000
Boats, row and seine	14	10,920	36	2,460	12	1,100	62	14,480
Lighters and scows	2	3,400	15	18,300	1	500	18	22,200
Pile drivers			1	3,000			1	3,000
Apparatus:								
Beach seines	2	1,200	8	9,450			10	10,650
Fathoms	300		890				1,190	
Purse seines	3	5,000	10	22,000			13	27,000
Fathoms	510		2,320				2,830	
Gill nets			16	3,275	60	1,200	76	4,475
Fathoms			775		1,000		1,775	
Impounding nets	4	2,000	7	8,500			11	10,500
Total		377,538		1,109,014		25,477		1,512,029
PERSONS ENGAGED.								
Fishermen:								
Whites	32		79		5		116	
Natives			1		11		12	
Total	32		80		16		128	
Shoresmen:								
Whites	61		206		5		272	
Natives			22		14		36	
Total	61		228		19		308	

Investment, persons engaged, and products of Alaska herring fishery in 1921—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
PERSONS ENGAGED—continued.								
Transporters:								
Whites	8						8	
Negroes	1						1	
Total	9						9	
Grand total	102		308		35		445	
PRODUCTS (POUNDS).								
Fresh for bait							1,660,048	$16,600
Frozen for bait							626,000	5,880
Pickled for bait							380,000	4,800
Pickled for food, Scotch cured							14,523,441	838,335
Pickled for food, Norwegian cured							406,250	20,433
Fertilizer							892,000	26,760
Oil							[1] 84,938	21,236
Total								934,044

[1] Gallons.

COD FISHERY.

The cod industry of Alaska suffered a material shrinkage in production in 1921, due primarily to unsatisfactory market conditions and consequent large holdover of the output of 1920. The unsold stock was sufficient to discourage normal activities, and the situation was further aggravated by labor difficulties. Most of the smaller concerns, chiefly shore-station producers, did not resume operations in 1921.

In the vessel fishery all of the larger producers were represented except the Robinson Fisheries Co., which meant the withdrawal of the schooners *Alice* and *Wawona.* The Union Fish Co. reduced its fleet by withdrawing the *Galilee, Beulah, Chas. E. Brown, Eunice,* and *Carolyn Frances,* the latter making one whaling voyage to Alaska waters. The *Fanny Dutard,* owned by J. A. Matheson, after being diverted to other trades for more than a year, reentered the Alaska cod fleet and made one voyage to Bering Sea.

The only important shore stations opened in 1921 were those of the Union Fish Co. and the Alaska Codfish Co., in the Shumagin Islands.

Alaska cod fleet in 1921.

Name.	Rig.	Net tonnage.	Operators.
City of Papeete	Schooner	370	Alaska Codfish Co., San Francisco, Calif.
Glendale	do	281	Do.
Maweema	do	392	Do.
S. N. Castle	do	464	Do.
Alasco	Power schooner	23	Do.
Alasco II	do	5	Do.
Alasco III	do	8	Do.
Alasco IV	do	14	Do.
Fanny Dutard	Schooner	252	J. A. Matheson, Anacortes, Wash.
John A.	do	235	Pacific Coast Codfish Co., Seattle, Wash.
Maid of Orleans	do	171	Do.
Sequoia	do	324	Union Fish Co., San Francisco, Calif.
Louise	do	328	Do.
Martha	do	14	Do.
Golden State	Power schooner	223	Do.
Progress	do	115	Do.
Mary E.	do	21	Do.
Pirate	do	30	Do.
Union Flag	do	7	Do.

STATISTICAL SUMMARY.

The cod industry in Alaska in 1921 showed an investment of $781,665, as compared with $2,057,728 in 1920. The total number of persons employed was 332, or 471 less than in 1920. The production of cod was 4,787,831 pounds, valued at $457,320, which is 7,976,068 pounds less than the quantity produced in 1920.

Investment, persons engaged, and products of Alaska cod fishery in 1921.

Items.	Number.	Value.
INVESTMENT.		
Value of shore stations		$127,741
Cost of operations		104,584
Wages paid		178,832
Vessels:		
Power, over 5 tons	8	132,722
Net tonnage	439	
Sailing	11	174,880
Net tonnage	2,838	
Launches	91	42,188
Dories	283	9,056
Pile drivers	3	3,603
Apparatus:		
Seines (75 fathoms)	1	250
Gill nets (75 fathoms)	1	195
Lines	1,175	7,614
Total		781,665
PERSONS ENGAGED.		
Fishermen: White	275	
Shoresmen: White	16	
Transporters: White	41	
Total	332	

Items.	Number.	Value.
PRODUCTS (POUNDS).		
Vessel catch:		
Dry-salted cod	2,611,530	$205,349
Pickled cod	35,500	1,775
Total	2,647,030	207,124
Shore-station catch:		
Dry-salted cod	899,130	126,025
Pickled cod	1,241,211	124,121
Stockfish	460	50
Total	2,140,801	250,196
Total:		
Dry-salted cod	3,510,660	331,374
Pickled cod	1,276,711	125,896
Stockfish	460	50
Grand total	4,787,831	457,320

WHALE FISHERY.

Whaling in Alaska in 1921 was limited to the operations of the Western Whaling & Trading Co., of San Francisco, which carried on a vessel fishery in the vicinity of Kodiak Island during the summer months, using for that purpose the schooner *Carolyn Frances,*

of 320 tons burden. The vessel, including equipment, was valued at $175,000. Employment was given to 20 whites and 1 negro, to whom $15,334 were paid in wages. A catch of 79 whales was made, consisting of 1 California gray, 2 finbacks, 1 sperm, and 75 humpbacks. From these 57,000 gallons of oil were obtained, valued at $19,950.

The shore stations of the United States Whaling Co., at Port Armstrong, and of the North Pacific Sea Products Co., at Akutan, did not operate in 1921, owing to the unsatisfactory market for whale products.

SHRIMPS.

The shrimp fishery of southeast Alaska is attaining increased importance as a distinct industry, four companies at Petersburg and Wrangell having exported shrimp products in 1921. Those at Petersburg were the Alaskan Glacier Sea Food Co., the Petersburg Sea Products Co., and the Ness Fish Co. T. A. Heckman operated the floating plant of the Olympic Fisheries Co., at Wrangell. Shrimp canning has not been undertaken except experimentally. The exported product is called "fresh shrimp meat" which is processed by steaming sufficiently to enable easy removal of the shells, after which the meat is packed in tin containers holding about 6 pounds each. Owing to the perishability of this product it must be marketed promptly. Inadequate facilities for shipment caused a loss of shrimp meat at Petersburg, valued at $4,400.

The investment in the shrimp industry in 1921 was $147,814, as compared with $76,100 in 1920, and 111 persons were employed as against 20 in the previous year. The products in 1921 were 344,986 pounds of fresh shrimp meat, valued at $132,077, as compared with 112,045 pounds in 1920, valued at $49,123.

Investment, persons engaged, and products of the southeast Alaska shrimp fishery in 1921.

Item.	Number.	Value.	Item.	Number.	Value.
INVESTMENT.			PERSONS ENGAGED.		
Plants	3	$22,800	Whites	21	
Operating capital		96,394	Natives	52	
Boats, power	5	26,000	Japanese	37	
Beam trawls	7	2,620	Mexicans	1	
Total		147,814	Total	111	
			PRODUCTS (POUNDS).		
			Meat, fresh	344,986	$132,077

CRABS.

The wide distribution and probable abundance of crabs in Alaska has been referred to in earlier reports on the fisheries of Alaska by the bureau, and the possible successful utilization of them for export has been repeatedly suggested. Perhaps the most promising development of the shellfish industry of Alaska in 1921 was the canning of crabs as a commercial enterprise. In previous seasons the use of these crustaceans was limited to supplying them in the shell to markets in Alaska and Seattle and to experimental canning, the latter

having been attempted at Seldovia in 1920 by the Arctic Packing Co. and Eda O. Kitzman.

In 1921 the Dobbins Packing Co., of Newport, Oreg., undertook the canning of crabs at Wrangell on a scale never before attempted in Alaska. Operations began in May and were continued until the middle of December, and a pack of 2,841 cases of 48 one-half pound cans per case was made. Crab canning was carried on at Petersburg also by Ellson & Malcolm who shipped from Alaska, according to customhouse record, a total of 1,174 cases of half-pound cans of crabs. The Arctic Packing Co., at Seldovia, similarly prepared 60 cases, thus making the total pack of canned crabs 4,075 cases. John Murphy, at Tenakee, sold locally 200 dozen crabs in the shell.

The reported investment in the crab industry of Alaska in 1921 was $43,848. Employment was given to 44 persons. The products consisted of 4,075 cases, valued at $32,780, and 200 dozen crabs, valued at $400. The reported value of Alaska crab products the previous year was $1,740. In view of the interest in the possibilities of successful crab fishing and the building up of an independent industry, Warden Fred H. Gray gathered important data covering interesting phases of the situation as it existed in 1921. His report is as follows:

Edible crabs are very generally distributed throughout the waters of southeast Alaska, but the regions of known abundance are the waters of Duke and Mary Islands, the southern part of Gravina Island, Moira Sound, Cholmondeley Sound, Kasaan Bay and its arms, Skowl Arm, Thorne Bay, Lake Bay, Whale Passage, and the shore waters of Prince of Wales Island from Exchange Cove to the head of Red Bay. On the west coast of Prince of Wales Island crabs are fairly abundant from Shakan Bay to Klawak Inlet and in the adjacent waters of Portillo Channel, St. Nicholas Canal, and Port Real Marino. In fact, all waters along the western shore of Prince of Wales Island are regarded as good crab regions. Along the mainland from Point Caamano to the Stikine River the crab zone is mostly narrow, though the island waters are better. Just off the Stikine flats are some of the best known crab waters in Alaska. Wrangell Strait, Beecher Pass, Blind Slough, Duncan Canal, and the southern part of Frederick Sound are also good waters for crabs. Excepting a few localities the waters of Kuiu Island are not considered good. Pybus Bay and Gambier Bay are said to be good crab districts. Some crabs are also taken along the shores of Icy Strait. Sitkoh Bay and Peril Strait, with its numerous bays, are among the best crab grounds in southeast Alaska. Tenakee Inlet has long been noted for its excellent crabs. The inside waters from Salisbury Sound to Sitka are largely within the crab zone.

Several years ago John Mantle supplied Wrangell with crabs caught in Red Bay. John Murphy continues to supply the Juneau markets with Tenakee Inlet crabs. C. M. Coulter and associates, of Wrangell, carried on successful crab fishing in Blind Slough and Frederick Sound. Their catches were cooked and shipped to Seattle in the shell, but owing to the irregular steamer service at that time the business was unprofitable and they were obliged to suspend operations. Crabs have always been used locally by both whites and natives. In 1921 the Dobbins Packing Co. operated a floating cannery at Wrangell from May to December and packed approximately 2,500 cases of crabs. The regular crew consisted of six men, and in addition from 20 to 25 pickers, chiefly women, were employed in the cannery. Ellson & Malcolm operated a small cannery at Petersburg and packed approximately 1,200 cases, using Japanese labor exclusively. These companies used only the common species of crab found in shallow water. At Sitka crab canning has been undertaken by the Oregon Alaska Packing Co., but as yet the company has done little more than prospect localities and experiment with crab traps. This company intends to can "spider" crabs, which are usually found in comparatively deep water.

Crabs are caught in traps made of iron rods forming a framework that is covered with wire netting, except the ends, which are equipped with linen or cotton web tunnels through which the crabs may enter. The traps, which are about 40 inches long, 30 inches wide, and 20 inches deep, are baited with fish or salmon-cannery offal and set during the summer in water from 2 to 8 fathoms deep, and in winter to depths

of 25 fathoms. The traps are lifted at frequent intervals and the catch removed and sorted. Only crabs measuring 6 inches or more in breadth are saved. The others, which include all females, are released. The large ones are placed in a live-box and taken to the cannery. Crabs will live out of water for about 12 hours if kept in a cool place, and if kept in sea water they will live much longer. They feed on dead fish, animal matter, and such marine forms as they can catch. Moreover, they are cannibalistic and often kill and devour their own kind. If crabs of different sizes should be placed in a small tank, it would not be many days before there would be but one left, and it, the largest of the lot, the others because of their lesser size having become the legitimate prey of the largest one.

Near the mouths of creeks and rivers crabs seem to be most abundant, perhaps because the streams have made deposits of silt, forming suitable depths of water. The matured female crabs measure from 4 to 5½ inches in width and are not offered for sale, which is a fortunate circumstance in the preservation of the species. Common crabs have been found from August to December carrying their eggs, but they are not then taken on open sand or mud bottoms, as they prefer to inhabit rocky bottoms and patches of seaweed. Crabs have been found shedding their shells from June 17 to August 9, but molting occurs chiefly in July. They are not then fit for food, as the meat is soft and watery and much of their substance is required to make the rapid growth of both body and shell. During the molting stage they seek protection in secluded places.

When the crabs are delivered at the cannery, they are first placed in boiling water for about 15 minutes, after which they are taken by the sides and struck across a sharp edge of wood along the center of the back, thus breaking them into two pieces. The digestive organs are then removed and the meat is washed clean, preparatory to its being picked out of the shell and packed in half-pound cans lined with oiled paper. The body and leg meat is placed in the cans in alternate layers, and when the cans are filled the edge of the paper lining is folded over the meat so that the meat does not come in contact with the tin. The cans are next put through the capping machine, which caps and seals them, and then into the retort for cooking, which requires 50 minutes. When prepared for shipment a case of crabs contains 48 one-half pound cans. The average amount of meat from a 6 to 9 inch crab is a little less than 8 ounces.

MINOR FISHERIES.

TROUT.

The production of trout in 1921 was 133,504 pounds of fresh, frozen, and pickled Dolly Vardens and steelheads, valued at $18,925, as compared with a production of 99,030 pounds, valued at $13,155, in 1920. The bulk of the output came from southeast Alaska. There is no investment in this business, as no exclusively trout industry or fishery exists. The catch of trout is incidental to fishing for salmon.

Products of Alaska trout fishery in 1921.

Species.	Fresh.		Frozen.		Pickled.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Dolly Varden	108,872	$16,105	1,705	$170		
Steelhead	5,091	400	14,036	1,965	3,800	$285
Total	113,963	16,505	15,741	2,135	3,800	285

CLAMS.

The production of clam products in Alaska in 1921 was limited to a pack of 1,420 cases of whole clams by the Surf Packing Co. at Tuxedni Harbor, in the Cook Inlet district, incidental to the canning of salmon. The pack was valued at $9,940. The total Alaska pack of clam products in 1920 was 6,833 cases, valued at $46,812.

The Pioneer Packing Co., which has canned clams at Cordova for several seasons, did not resume such activities in 1921. One reason was said to be the decreased supply of clams in that region. The Douglas Island Packing Co., at Douglas, likewise did not resume clam canning in 1921.

MISCELLANEOUS FISHERY PRODUCTS.

Under this classification are shown the quantity and value of certain species for which no recognized fishery exists. These products, of which sablefish constitute the greater part, are obtained chiefly in fishing for halibut on the offshore banks of Alaska. In 1921 the output of fresh, frozen, and pickled sablefish was 392,767 pounds, valued at $17,985; the production of red rockfish was 12,658 pounds, valued at $362; and of smelts, 2,000 pounds, valued at $50.

FUR-SEAL INDUSTRY.

PRIBILOF ISLANDS.

GENERAL ADMINISTRATIVE WORK.

In 1921 the seal and fox herds on the Pribilof Islands were given the greatest possible care and attention. A different method of skinning seals, whereby the use of the knife is practically eliminated in removing the skin, was successfully tried. A large number of skins were blubbered on the islands, resulting in a better cured and more easily handled product. The fox herd, if the take of skins on St. George Island during the winter of 1920–21 is indicative of its size, will break all previous records in a few years. The amount of winter food available will soon be an important influence upon its size. Construction work was continued on several native dwellings. On St. George Island a large shop and warehouse was built, providing necessary facilities for handling the increasing catch of fox skins. An electric lighting system was installed. On St. Paul Island additions were made to both salt houses and the installation of a water-supply system was begun. The usual seal census was made. Annual supplies were transported to the islands by the Navy Department and completely discharged at both islands in record time. The Coast Guard vessels performed their usual patrols and rendered valuable assistance in the transportation of personnel and supplies. The bureau's vessel *Eider* proved indispensable, especially early in the year, in carrying necessary supplies to the islands.

PERSONNEL.

Agent and Caretaker C. E. Crompton, who had been detailed to the Washington office during the previous winter, returned to duty on St. George Island on the U. S. S. *Saturn*, arriving there August 3. Superintendent A. H. Proctor left for the States on October 19 on the *Unalga*, and after a period of annual leave spent on the Pacific coast reported at Washington January 6, 1922, for duty through the winter. On departure of Mr. Proctor, Agent and Caretaker H. D. Aller was designated acting superintendent. Storekeeper E. C. Johnston left St. George Island August 13 on the *Saturn* for the States, and after a period of annual leave reported at the Washington office November 9 for duty during the winter. Henry C. Scudder, storekeeper assigned to St. Paul Island, was transferred to St. George Island on August 5. Richard Culbertson, school-teacher on St. Paul Island, left on the *Saturn* June 17 for a visit to his home and returned on the next trip of the *Saturn*, early in August. Dr. G. B. Bowlby, who was appointed physician on St. Paul Island late in 1920 and was en route to the islands at the end of the year, was landed at St. Paul Island March 11 by the *Eider*, storms having prevented an earlier passage from Unalaska. Mrs. A. H. Proctor resigned as school-teacher on St. Paul Island October 16, and left the islands on the

Unalga October 19. Mrs. Edna C. Mygatt was appointed schoolteacher as successor to Mrs. Proctor, and entered upon duty October 17. Warden Joseph N. Braun, who had been detailed to St. George Island for duty during the winter, left May 9 on the *Eider* for Unalaska and returned to his regular duties in respect to the salmon fisheries.

W. C. Allis, special sealing assistant, and A. Christoffersen, by-products expert, returned to St. Paul Island May 24, passage from the States having been on the *Unalga* to Unalaska, thence on the *Eider*. Three carpenters from Seattle were also employed on the islands from May to October, Andrew Pearson being assigned to St. George Island, and Ole Holum and John Rafdal to St. Paul Island. The following employees of the Fouke Fur Co. were at St. Paul Island from June to August to assist in sealing operations: W. P. Zschorna, Frank Milligan, Oliver Klockenbrink, Mike Syron, William Fueglein, Paul Katz, George Neidel, and Jacob Marks. Dr. Daniel L. Roland, dentist, went to St. Paul Island on the July trip of the *Saturn* and remained over the winter.

PURCHASE AND TRANSPORTATION OF SUPPLIES.

As in previous seasons, printed schedules of annual supplies of general merchandise required for the Pribilof Islands were prepared and competitive bids received, Seattle, Wash., being the shipping point. Through the courtesy of the Navy Department the radio station tender U. S. S. *Saturn* was made available for the transportation of part of the bureau's supplies on two trips of the vessel to the Pribilof Islands.

On the first trip the *Saturn* left Seattle May 16, having on board for the bureau 126,000 feet of lumber, 184 tons of general merchandise, including 112 tons of salt, and also 50 tons of coal to be delivered at St. George for repayment to the Radio Service from which it had been borrowed. The vessel arrived at the islands June 11. On a second trip from Seattle, July 22, and arriving at the islands August 3, the *Saturn* carried 675 tons coal, 4,485 feet lumber, 27 tons fuel oil, and 366 tons general merchandise for the bureau. The *Eider* assisted the *Saturn* in unloading and transferring cargo at the islands and at Unalaska.

The Coast Guard cutter *Unalga* made two trips between Unalaska and the Pribilofs in June, transferring lumber which had been left at Dutch Harbor the previous fall by the *Saturn*. The auxiliary schooner *Ruby*, operated by the Kuskokwim Fishing & Transportation Co., was utilized also for the transportation of supplies, leaving Seattle May 21 and arriving at the islands June 18. The vessel carried 67,000 feet lumber, 35 tons salt, and 64 tons general merchandise. About 200 tons of general cargo were forwarded from Seattle August 16 on the *Oregon*, owned by the Alaska Commercial Co. The vessel reached the islands September 12 and finished unloading and departed September 14.

The Bureau of Fisheries greatly appreciates the courteous cooperation extended by the Navy and the Coast Guard in transporting supplies and persons to the Pribilof Islands.

POWER SCHOONER "EIDER."

At the beginning of the year the bureau's power schooner *Eider* was at Kodiak undergoing repairs. After leaving there the *Eider* located the missing mail boat *Pulitzer* at Chignik. A large amount of mail and several passengers were taken from the disabled vessel and transported to Unga and Unalaska.

Very valuable service was rendered by the *Eider* during the calendar year 1921, some of the work being under particularly arduous conditions. A total of 7,300 miles was covered and 134 passengers carried. Seven trips to the Pribilof Islands were made from Unalaska, one in each of the months February, March, April, May, June, August, and September. The first trip was made early in February. Such severe weather was encountered that, after remaining at anchor off St. George Island three days, ice and wind compelled the vessel to return to Unalaska without making a landing. Two trips were in the vicinity of Belkofsky and Unalaska to secure native workmen for temporary duty on St. Paul Island. A naval radio operator from Dutch Harbor was detailed to the *Eider* on the March trip to the Pribilof Islands. In addition to supplies transported for the Pribilofs on each trip stores for the naval radio station on St. Paul Island were carried by the *Eider* at various times. During the period the U. S. S. *Saturn* was delivering the annual supplies for the bureau the *Eider* was placed under the orders of the commanding officer of that vessel and rendered assistance both at Unalaska and at the islands in the landing of the supplies.

In September the *Eider* proceeded to Kodiak for necessary annual overhauling and returned to Unalaska in December. The more important repairs or changes were an increase in the area of iron bark on the hull, enlarging of engine room space, installation of engine room ventilators, rearrangement and increase in number and size of staterooms, raising forecastle deck rail 12 inches, and raising and remounting the winch. The vessel was at Unalaska at the close of the year.

NEW FUR-SEAL AND SEA-OTTER REGULATIONS.

Under date of April 21, 1921, a new departmental circular, No. 285, was issued by the Secretary of Commerce embodying the laws and regulations for the protection of fur seals and sea otters. It contains a reprint of the act of April 21, 1910, the fur-seal convention between Great Britain, Russia, Japan, and the United States signed July 7, 1911, the act of August 24, 1912, giving effect to the convention, and the presidential proclamation of May 31, 1913, for the preservation and protection of fur seals and sea otters. The revised regulations which appear in the circular are as follows:

FUR SEALS.

1. Persons lawfully landing on any of the Pribilof Islands, whether to remain temporarily or otherwise, must confine themselves to their lawful activities, and any visiting of rookeries or hauling grounds of seals or sea lions must first be authorized by the department's agents in charge.
2. In order that persons authorized or permitted to land may have an opportunity to observe the seal life, the department's agents in charge will provide escorts, at convenient times, to accompany interested persons to proper observation points.

No side digressions from the designated observation points will be permitted, and there will be no visiting of rookeries except under such escorts. On St. Paul Island the usual observation point for persons temporarily present shall be what are commonly known as Observation Rocks at Gorbatch rookery.

3. Persons authorized to land at St. Paul Island, whether to remain temporarily or otherwise, are required, except under circumstances specifically authorized by the department's agent in charge, to remain on that portion of the island in and about the village of St. Paul which is bounded by the shore line, including that of the salt lagoon and its outlet, and two straight lines running approximately as follows: The first from the shore at Black Bluffs to the southerly portion of the salt lagoon, passing to the eastward of the natives' cemetery, the natives' wells, and the by-products plant; the second to cut across the isthmus at Zolotoi Sands. The land lines as described will be indicated by notices posted at suitable intervals.

4. Any person willfully violating these regulations will be regarded as a trespasser and will be required to leave the islands at the first opportunity, or will be subject to such other action as may be deemed appropriate.

5. In order to prevent molestation of the fur-seal and fox herds, the landing of any dogs at the Pribilof Islands is hereby prohibited. Officials in charge of St. Paul and St. George Islands will enforce this regulation.

SEA OTTERS.

The killing of sea otters in the waters of Alaska is prohibited until November 1, 1925.

CONSTRUCTION WORK.

During the year alterations and repairs were made to the buildings on the Pribilof Islands where necessary for the economical maintenance of the stations. On St. Paul Island a 50-foot addition was extended on the end of the new salt house and an addition of the same size to the old salt house was started. This will be completed in time for the 1922 season. A building 32 by 70 feet was erected to house the sealskin washing and blubbering operations. It contains the washing tanks, blubbering beams, motor-driven wringer for drying skins, tables, and other equipment. On Village Hill a building 100 by 32 feet was put up to contain four 40,000-gallon tanks, from which fresh water will ultimately be distributed to the village by gravity. Approximately 500 feet of 4-inch wooden pipe line was laid. This will connect with the artesian well, the boring of which has been undertaken in cooperation with the Navy. (See page 54.) A temporary wharf was installed at East Landing, St. Paul Island, which will be made permanent as soon as material and time are available. In construction work on both islands concrete has been used in foundations, floors, etc., wherever possible.

On St. George Island a new general shop and warehouse, 30 by 60 feet, was constructed. This building is $3\frac{1}{2}$ stories in height, including the basement. Two small houses were built, one for paint and the other for dynamite. A concrete native dwelling was nearly completed. Preliminary work has been done on a new dispensary, hospital, and physician's quarters.

WATER SUPPLY ON ST. PAUL ISLAND.

In 1921 considerable progress was made in the matter of improving the water supply for the village on St. Paul Island. A large quantity of pipe, consisting chiefly of 4-inch wooden main and 2-inch laterals, was purchased and sent to St. Paul Island. Also two 40,000-gallon tanks were purchased at the same time. A site was selected for the tanks on the hill in the rear of the village and concrete foundations

were prepared. Approximately 500 feet of trench about 6 feet in depth was dug, in which the 4-inch pipe was laid from the tanks down to the center of the village. The work in the coming season will be continued by the erection of the storage tanks and the laying of lateral-supply pipes on the various streets of the village.

The general plan, which is being developed along lines suggested by A. Christoffersen, is to pump water to the large tanks on the hill and thence distribute it by gravity through the village. The source of the supply will be dependent upon the results of well-drilling operations to be conducted in cooperation with the Navy Department. If artesian water is not thus secured, it is planned to continue the pipe line to a series of wells on the flat near the village, or possibly to icehouse pond, about 6,000 feet distant.

In 1920 an attempt was made by the Navy Department to drill an artesian well but without success, owing to inadequate equipment. In 1921 the work was again undertaken, the bureau bearing part of the expense. Two attempts were made, one about half a mile from the village and the other on the hill adjacent to the village. Both projects failed, because the available casing was exhausted and other difficulties were encountered which could not be overcome with the equipment at hand. It is felt that the chances for success in 1922 are much better because of the experience in the preceding seasons and improved facilities. The expense is to be borne jointly by the Navy Department and the bureau. The former is interested because of the desirability of improving the water supply at the radio station.

BY-PRODUCTS PLANT.

The by-products plant on St. Paul Island began operations on June 27 and closed August 14, 1921. The output during this period was 1,270 gallons "A" oil, 3,030 gallons "B" oil, 921 gallons press oil, 50 gallons of foots, and 76 sacks containing 8,759 pounds of fertilizer meal. The plant, however, was not operated to its full capacity. There were shipped to Seattle on the U. S. S. *Saturn* 128 sacks of meal held over from 1920 and 74 sacks of meal made in 1921; also, 47 barrels of oil for the Fouke Fur Co., St. Louis, were forwarded. In addition, five barrels of oil were shipped on the Coast Guard cutter *Unalga* to the Fouke Fur Co. Fifty gallons of oil foots were sent to St. George Island for the experimental feeding of foxes. The meal was disposed of in Seattle at the rate of $17.50 per ton, or a total of $139.13. The proceeds were covered into the United States Treasury.

IMPROVED SEALING METHODS.

In the summer of 1921 experiments were undertaken and subsequently developed along practical lines which have resulted in what are regarded as notable improvements in the method of taking fur-seal skins. In the past the pelts have been removed by the native workmen in the ordinary manner of skinning animals. Notwithstanding the utmost care even by the most skilled workmen, cuts or flays would occasionally result on the underside of the pelt. This naturally lessened the value of the skin when finally made ready for market. In 1921, however, a method was developed of removing the pelts, so that it was necessary to use the knife only to slit the skin along the

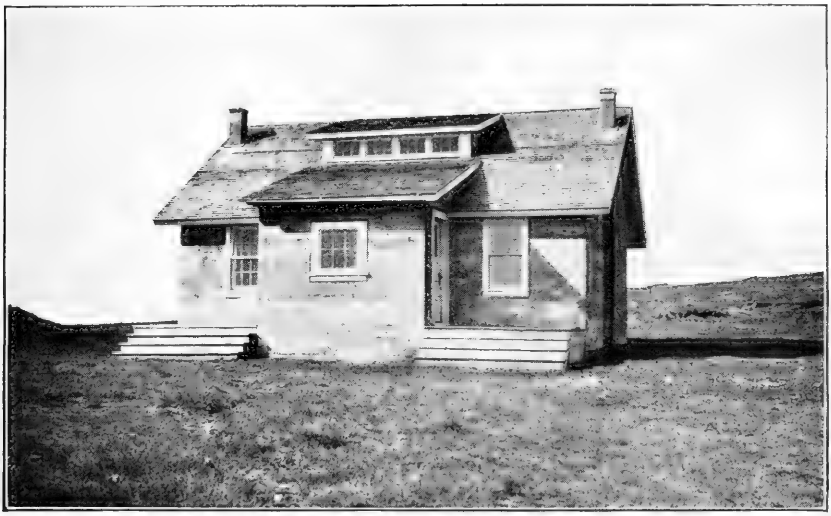

FIG. 14.—TYPE OF CONCRETE HOUSE BEING BUILT ON PRIBILOF ISLANDS FOR NATIVE RESIDENTS.

FIG. 15.—NEW WORKSHOP AND STORAGE BUILDING ON ST. GEORGE ISLAND.

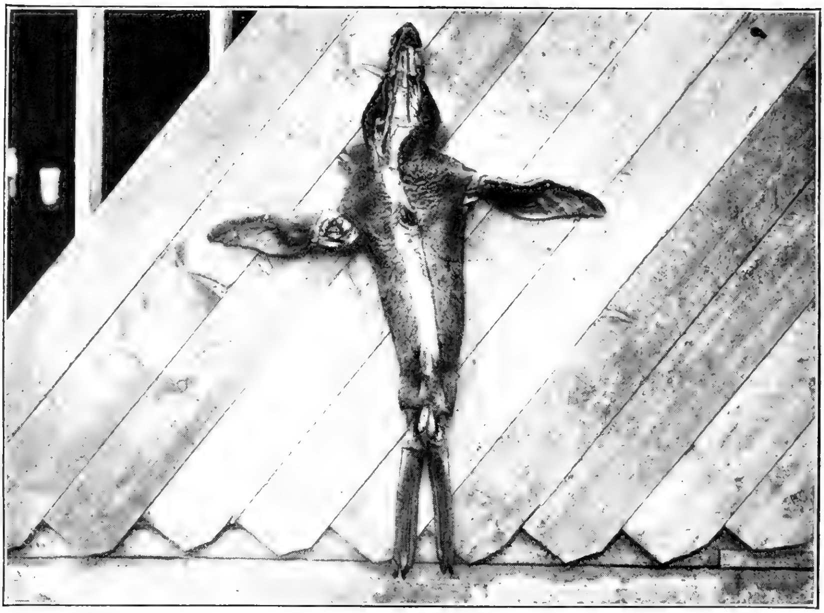

FIG. 16.—FUR-SEAL CARCASS SHOWING CUTS PRELIMINARY TO REMOVING PELT BY STRIPPING METHOD, ST. PAUL ISLAND.

FIG. 17.—STRIPPING PELT FROM FUR SEAL, ST. PAUL ISLAND.

abdomen and to cut around the head and flipper holes. Each carcass was pinned to the ground by an iron bar and the skin pulled off. All skins taken by this stripping method have a layer of blubber and meat remaining on them which must be removed before salting. The elimination of the knife in skinning is very important in that it lessens the chances of cutting or flaying the skins by the workmen and results in a better product.

A natural corollary of this improved method is that of washing the skins and blubbering them at the islands. Approximately 11,000 skins were treated in this manner at St. Paul village in the season of 1921. This work was carried on by a party of eight special sealing assistants, headed by W. P. Zschorna, from the Fouke Fur Co., St. Louis, Mo. Their efforts were devoted, primarily, to the blubbering, washing, and salting of the skins taken at St. Paul village. The skins thus handled are undoubtedly of superior quality, as evidenced by results in dressing, dyeing, and machining at the plant at St. Louis. This naturally means increased revenue when the skins are marketed. It is the purpose to expand the use of the improved methods at the islands.

NATIVES.

HEALTH CONDITIONS.

In general, the health of the natives of the islands during the calendar year was good. No serious epidemic of any kind occurred. During the year there were eight births on St. George Island and no deaths and seven births on St. Paul Island and five deaths. Owing to the inability of Dr. Bowlby to land at St. Paul Island until March 11, the island was without a physician from the time of the departure of Dr. Richstein and Dr. Huyler in the previous November. Very fortunately there were no deaths on the island during this period. A dentist was sent to the islands in August and has remained over the winter, carrying on the work so well started in the previous summer.

SCHOOLS.

St. Paul Island reported an attendance of 12 boys and 13 girls in the senior school and 11 girls and 15 boys in the junior school at the term beginning November 15, 1920. School sessions were held on 105 days. General textbooks were used, with special emphasis on the speaking and writing of English, which is the urgent need of the Aleut children. Suitable forms of athletics were encouraged and directed by the teachers, and the teaching of hygiene was given attention.

St. George Island reported an attendance of 15 boys and 22 girls in the senior school and 4 girls and 3 boys in the junior school at the term beginning in the fall of 1920. The schools were closed during November on account of a shortage of coal. Only one regular full-time teacher is employed on St. George Island. The so-called junior school consists of a few very small children who are given some preparatory training by a part-time teacher to help them become accustomed to school routine. One peculiarity distinguishing the Aleut child from the average white child is the greater individual attention required to enable them to grasp the meaning of things taught. A second full-time teacher is greatly needed on St. George

Island. During the winter of 1920–21 Mrs. Ella Jeanette Johnston took charge of the small children, and upon her departure in the summer of 1921 Mrs. Orchard took up the work.

ATTENDANCE AT SALEM INDIAN TRAINING SCHOOL, CHEMAWA, OREG.

No additional pupils from the Pribilofs were enrolled at the Salem Indian Training School during the year; the attendance therefore remains the same as at the close of 1920.

Pribilof Islands natives at Salem Indian Training School, December 31, 1921.

Fratis, Mrs. Akalina [2]	Resident of St. Paul Island.
Fratis, Ouliana [2]	Do.
Stepetin, Nicolai	Do.
Stepetin, Vasilii	Do.
Lekanof, George	Resident of St. George Island.
Merculief, Laurence	Do.

SAVINGS ACCOUNTS.

Certain of the Pribilof Islands natives have personal funds in the custody of the United States Commissioner of Fisheries. These funds are still on deposit with the Washington Loan & Trust Co., Washington, D. C., and draw interest at 3 per cent per annum, calculated on monthly balances. The account of one native, Parascovia Kozloff, of St. Paul Island, was closed during the year. The condition of the account as a whole on December 31, 1921, is shown in the statement which follows:

Balance on hand Jan. 1, 1921	$2, 839. 87
Interest earned from Jan. 1 to Dec. 31, 1921	83. 29
Deposited by natives during above period	38. 25
	2, 961. 41
Withdrawn by natives during above period	235. 18
Balance on hand Dec. 31, 1921	2, 726. 23

An itemized statement of the account showing the individual balances of the natives follows:

Pribilof Islands natives' savings accounts in the custody of the United States Commissioner of Fisheries, as trustee, December 31, 1921.

St. Paul Island:	
Bourdukofsky, Apollon	$93. 13
Bourdukofsky, Peter	. 90
Fratis, Agrifina [3]	95. 69
Fratis, Akalina [3]	463. 60
Fratis, Martha [3]	95. 70
Fratis, Ouliana [3]	95. 70
Gromoff, Iuliania	359. 29
Krukoff, Ekaterina	203. 86
Krukoff, Iuleta	9. 16
Mandregan, Alexandra M.	10. 53
Melovidov, Alfey	44. 41
Melovidov, Anton	3. 80
Melovidov, Iosef	44. 41
Merculieff, Agafia	39. 82
Merculieff, Dosofey	39. 82
Merculieff, Makary	39. 82
Merculieff, Mariamna	66. 33
Merculieff, Paul A.	15. 62
St. Paul Island—Continued.	
Pankoff, Agrippina	$242. 79
Pankoff, Maria M.	44. 42
Sedick, Feofania	13. 87
Sedick, Lavrenty	13. 87
Sedick, Leonty	13. 87
Sedick, Marina	. 38
Tetoff, Vikenty M.	44. 41
St. George Island:	
Borenien, Zoya [4]	243. 13
Galanin, Mary	92. 22
Lestenkof, Michael	134. 62
Merculief, Agrippina	66. 47
Merculief, Joseph	34. 76
Merculief, Polyxenia	19. 13
Shane, Michael	40. 25
Zacharof, Emanuel	. 45
Total	2, 726. 23

[2] Mother and daughter employed at the school.
[3] Not living on island in 1921.
[4] Deceased; estate undivided.

PAYMENTS FOR TAKING SEALSKINS.

Following the plan of preceding seasons, funds for paying certain persons engaged in sealing operations at the Pribilofs in 1921 were advanced by the Fouke Fur Co. and the firm was duly reimbursed from the proceeds of the sale of the dressed and dyed skins. Under this arrangement the funds were deposited in a Seattle bank to the credit of the bureau's authorized and bonded agent at the Pribilofs, who issued checks against the deposit covering accounts payable therefrom.

The practice of paying the island natives for their labor in taking skins was continued. They were paid on the basis of 50 cents each for skins taken during the summer season from seals up to and including the 6-year-old class, and $1 each for skins from seals of 7 years and upward. No payments were made for labor in taking skins from seals killed in the fall season.

Payments from funds advanced by the Fouke Fur Co. for sealing operations in the calendar year 1921 were as follows:

Salaries of sealing assistants, St. Paul Island	$9,332.80
Wages of Aleutian Islands natives at St. Paul Island	11,347.47
Amount earned by St. Paul natives 1921	9,347.00
Amount earned by St. George natives 1921	2,126.00
Total	32,153.27

St. Paul Island.—Of the 19,230 skins taken on St. Paul Island during the calendar year 1921, the native workmen received payment for 18,494 skins at the rate of 50 cents each, the other skins being from seals killed in the fall, for which payment was not made. The fund was divided among the participating natives according to their ability, as follows:

Payments to St. Paul natives for sealing operations, calendar year 1921.

Classification.	Number of men.	Share of each.	Total.	Classification.	Number of men.	Share of each.	Total.
First class	27	$243.00	$6,561.00	Sixth class	2	61.00	122.00
Second class	5	195.00	975.00	Two foremen (additional compensation)			100.00
Third class	6	159.00	954.00				
Fourth class	2	122.50	245.00				
Fifth class	4	97.50	390.00	Total	46		9,347.00

St. George Island.—Of the 4,451 skins taken on St. George Island during the calendar year 1921 the natives received payment at the rate of 50 cents each for 4,044 and $1 each for 4 skins, the remainder of the take being from seals killed in the fall season. The resulting fund was divided among the natives who took part in the operations according to the extent and proficiency of their work, as follows:

Payments to St. George natives for sealing operations, calendar year 1921.

Classification.	Number of men.	Share of each.	Total.	Classification.	Number of men.	Share of each.	Total.
First class	17	$78	$1,326	Boys' class	3	10	30
Second class	6	63	378	Two foremen (additional compensation)			100
Third class	4	51	204				
Fourth class	2	44	88	Total	32		2,126

PAYMENTS FOR TAKING FOX SKINS.

Following the plan of the past seasons, natives at the Pribilofs were paid for their labor in taking fox skins during the winter of 1920–21 on the basis of $5 for each skin secured. The funds are credited to each community as a whole and are later divided among the participating workmen according to the extent and skill of their work. On St. Paul Island 136 skins were taken, resulting in a total credit of $680 to be divided among 35 men. On St. George Island 1,003 skins were obtained, making a total credit of $5,015 to be divided among 30 men. These sums were paid from the proceeds of the sale of skins in September.

CENSUS.

The annual census of native inhabitants of the Pribilof Islands was taken, in pursuance of custom, as of March 31, 1921. The 14 natives of St. Paul Island residing elsewhere, as stated in the census of March 31, 1920, have taken up permanent residence at Unalaska and do not intend to return to the Pribilofs. A native boy, son of one of these families, who is attending school at Chemawa, is also, therefore, dropped from the St. Paul records. There are restored to the record two natives of St. Paul at Salem Indian Training School who were inadvertently omitted from the tabulation appearing in the preceding published report. Details of the census appear in the following statement:

Recapitulation of census of natives, Pribilof Islands, March 31, 1921.

St. Paul Island:	
Resident population Mar. 31, 1920	188
Births in year ended Mar. 31, 1921	12
	200
Arrivals in year (from St. George Island)	2
	202
Deaths in year	5
	197
Departures in year, permanent (to Unalaska)	5
	192
Departures in year, temporary (to Unalaska)	4
Total native resident population Mar. 31, 1921	188
Natives at Salem Indian Training School, Chemawa, Oreg	5
Others temporarily residing elsewhere	4
Total natives accredited to St. Paul Island	197
St. George Island:	
Resident population Mar. 31, 1920	128
Births in year ended Mar. 31, 1921	6
	134
Arrivals in year (from Unalaska)	1
	135
Deaths in year	10
	125

St. George Island—Continued.

Departures in year, permanent—

To Unalaska	1
To St. Paul Island	2
	3
Total native resident population Mar. 31, 1921	122
Natives at Salem Indian Training School, Chemawa, Oreg	2
Total natives accredited to St. George Island	124

Both islands:

Total resident population Mar. 31, 1921	310
Total natives temporarily residing elsewhere	11
Grand total natives accredited to Pribilof Islands	321

FUR-SEAL HERD.

QUOTA FOR KILLING.

On May 31, 1921, recommendation was made to the Secretary of Commerce regarding the number of seals which might be authorized for killing at the Pribilof Islands during the calendar year 1921, and the following quota was approved:

Quota of seals for killing on Pribilof Islands in 1921.

Age class.	St. Paul.	St. George.	Total.
3-year-olds	22,100	3,750	25,850
4-year-olds	3,000	450	3,450
5-year-olds	600	100	700
Total	25,700	4,300	30,000

Previous killings had reduced the number of surplus larger seals sufficiently close to the reserves required by law and necessary as a safe margin to furnish adequate breeding strength. Consequently this class was not drawn upon for further killings.

The bureau's representatives at the Pribilof Islands were given instructions that the above figures were subject to revision if conditions observed at the islands during the course of operations should make a change necessary. As the season advanced it was found that seals of the 5-year-old class did not appear on the rookeries in numbers that were to be expected. Approval was received from the Secretary of Commerce to discontinue the killing of 5-year-olds on July 19, 1921.

A change in the length of the regular summer killing season was approved by the Secretary of Commerce on June 4, 1921. Killings were discontinued with the close of business August 5, instead of August 10, as heretofore. This change was desirable on account of the fact that the number of cows appearing in the drives in the latter part of the season is abnormally heavy.

KILLINGS OF SEALS.

The total number of seals killed on both islands during the calendar year 1921 was 23,681. Details regarding the killings are shown in the table below.

St. Paul Island.—A total of 53 drives during the period June 2 to November 26, inclusive, secured 19,230 seals on St. Paul Island during the calendar year 1921. This includes a few odd skins of seals killed for food of watchmen at various times.

St. George Island.—On St. George Island 31 drives were made from June 8 to November 19, inclusive, and 4,451 seals were secured.

Seal killings on Pribilof Islands in 1921.

ST. PAUL ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.	Date.	Serial No. of drive.	Hauling ground.	Skins secured.
May 30	....	Vostochni	[1]2	July 18	28	Zapadni and Little Zapadni.	464
June 2	1	Sea Lion Rock	136	July 19	29	Gorbatch	1,151
June 7	....	Vostochni	[1]1	July 20	30	Tolstoi	249
June 11	2	....do	109	Do	31	Lukanin	222
June 21	....	....do	[1]1	July 21	32	Reef	208
June 24	3	Zapadni	304	July 23	33	Vostochni and Morjovi	610
June 25	4	Vostochni and Morjovi	707	July 24	34	Polovina	236
June 27	5	Reef and Gorbatch	433	July 25	35	Zapadni and Little Zapadni.	209
June 28	6	Tolstoi	488	July 26	36	Gorbatch	492
June 29	7	Polovina and Polovina Cliffs.	368	Do	37	Reef	294
June 30	8	Gorbatch	265	July 27	38	Tolstoi	261
Do	9	Zapadni	284	Do	39	Lukanin and Kitovi	127
July 2	10	Vostochni	275	July 29	40	Vostochni and Morjovi	610
Do	11	Morjovi	456	July 30	41	Little Zapadni	121
July 5	12	Zapadni	580	Do	42	Zapadni	332
Do	13	Little Zapadni	219	Aug. 1	43	Gorbatch	550
July 6	14	Tolstoi	287	Do	44	Reef	258
Do	15	Lukanin	36	Aug. 2	45	Tolstoi and Lukanin	28
July 7	16	Polovina, Polovina Cliffs, and Little Polovina.	254	Do	46	Vostochni and Morjovi	296
July 8	17	Gorbatch	1,276	Aug. 3	47	Zapadni	79
Do	18	Reef	577	Do	48	Little Zapadni	99
July 10	19	Vostochni	694	Aug. 4	49	Gorbatch	86
July 11	20	Morjovi	850	Do	50	Reef	86
July 13	21	Zapadni	324	Oct. 8	....	East Landing	[2]1
July 14	22	Gorbatch	1,027	Oct. 20	51	Gorbatch	219
July 15	23	Reef	130	Nov. 8	52	Vostochni	481
Do	24	Lukanin	56	Nov. 26	53	....do	15
Do	25	Tolstoi	321	Dec. 6	....	....do	[1]2
July 17	26	Vostochni	543		....	Miscellaneous during year.	10
Do	27	Morjovi	431			Total	19,230

ST. GEORGE ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.	Date.	Serial No. of drive.	Hauling ground.	Skins secured.
June 8	1	North	3	July 23	19	Zapadni	42
Do	2	Staraya Artil	3	July 25	20	North and Staraya Artil.	357
June 13	3	East Cliffs	19	July 27	21	East Cliffs and East Reef.	188
June 15	4	North	83	July 29	22	North and Staraya Artil.	189
June 21	5	North and Staraya Artil.	84	July 30	....	Zapadni	[3]1
June 24	6	North and East Cliffs	98	Aug. 1	23	North, East Cliffs, and East Reef.	264
June 27	7	Staraya Artil	148	Sept. 13	....	North	[4]1
June 29	8	North, East Cliffs, and East Reef.	257	Oct. 20	24	....do	92
June 30	9	Zapadni	71	Oct. 21	25	East Reef	73
July 2	10	North and Staraya Artil.	188	Oct. 26	26	North	57
July 5	11	North and East Cliffs	123	Oct. 29	....	Zapadni	[1]5
July 7	12	Zapadni	44	Do	27	East Cliffs	11
July 9	13	Staraya Artil	83	Nov. 3	28	North and Staraya Artil.	126
July 11	14	North, East Cliffs, and East Reef.	728	Nov. 7	29	East Reef	25
July 13	15	North and Staraya Artil	154	Nov. 10	....	North	[5]1
July 16	16	East Cliffs and East Reef.	144	Nov. 17	30	North and East Cliffs	8
July 18	17	North and Staraya Artil.	508	Nov. 19	31	Zapadni	4
July 20	18	North, East Cliffs, and East Reef.	269			Total	4,451

[1] Seals killed for natives' food.
[2] Seal found dead on beach.
[3] Injured seal found during pup count.
[4] Seal killed for fox food.
[5] Only 1 seal secured; killing not numbered.

AGE CLASSES OF SEALS.

As in previous years the seals killed were classified in accordance with the standards of sizes obtained from measurements of seals branded in 1912. The limits for the various age classes determined from measurements of such animals of definitely known ages are as follows:

Age standards of body lengths of seals, Pribilof Islands.

Age.	Lengths of summer seals.	Lengths of fall seals.	Age.	Lengths of summer seals.	Lengths of fall seals.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Yearlings	Up to 36.75	Up to 38.75	4-year-olds	46 to 51.75	48 to 53.75
2-year-olds	37 to 40.75	39 to 42.75	5-year-olds	52 to 57.75	54 to 59.75
3-year-olds	41 to 45.75	43 to 47.75	6-year-olds	58 to 63.75	60 to 65.75

Ages of seals killed on Pribilof Islands, calendar year 1921.

Age.	Summer (Jan. 1 to Aug. 5).			Fall (Aug. 6 to Dec. 31).			Grand total.
	St. Paul.	St. George.	Total.	St. Paul.	St. George.	Total.	
Yearlings	10		10				10
2-year-olds	222	21	243	38	13	51	294
3-year-olds	16,183	3,347	19,530	672	365	1,037	20,567
4-year-olds	1,795	609	2,404	2	13	15	2,419
5-year-olds	243	47	290		10	10	300
6-year-olds	9	2	11				11
7-year-olds and over	2	2	4				4
Cows [1]	48	20	68	6	2	8	76
Total	18,512	4,048	22,560	718	403	1,121	23,681

[1] The few cows reported above, about one-third of 1 per cent of the total taken, were accidentally and unavoidably killed. Every possible effort is made to avoid the killing of cows, but persons familiar with conditions at the islands will readily appreciate that once in a great while a cow is killed.

BRANDED SEALS.

This class of seals has furnished and will continue to furnish a large amount of valuable data concerning seals of known ages. Sufficient numbers have been killed each year so that the limits of the body lengths of yearlings, 2, 3, 4, 5, and 6 year old seals have been determined. While occasionally seals will be found whose length will exceed the limits established, the data secured fulfill all practical purposes. Two of the seals branded as pups in 1912 were killed on St. George Island in the calendar year 1921. They were, of course, 9 years old. A record of those killed in each year is published in the Annual Report of the Alaska Fisheries and Fur Industries for that year.

Records of branded 9-year-old male fur seals killed on Pribilof Islands, calendar year 1921.

Serial No. of skin.	Date of killing.	Island.	Carcass weight.[1]	Carcass length.	Green skin weight.	Trade classification.
			Pounds.	*Inches.*	*Pounds.*	
G6166	July 11	St. George	413	78.5	44	Wig.
G6167	July 20	do	305	79	41	Wig.

[1] Seals were bled before being weighed.

CENSUS.

The annual census of the fur-seal herd was taken in the summer of 1921. The report, by Edward C. Johnston, is printed in full on pages 78 to 85. The increase in the size of the areas covered by breeding seals has made it more and more difficult to secure an accurate census.

On Reef rookery, St. Paul Island, two counting towers were erected before the seals arrived in the spring. These counting towers were built in the form of a tripod with the apex about 24 feet above the ground. A runway, 6 feet in height, extended from the tripod to the rear of the rookery, providing a safe means of reaching the tripod. The counting towers were placed just above the high-water mark on the beach and within the area occupied by the breeding seals. From the top of the towers the observer was able to get an unobstructed view of all the breeding seals and was not forced to divide his attention between the movements of dangerous bulls and the work in hand. The experiment has proved successful, and additional counting towers will be erected in 1922.

The following is a comparative statement of the numerical strength of the various elements of the herd in the years 1912 to 1921, inclusive:

General comparison of recent censuses of the seal herd on Pribilof Islands.

Classes.	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
Harem bulls	1,358	1,403	1,559	2,151	3,500	4,850	5,344	5,158	4,066	3,909
Breeding cows	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172	167,527	176,655
Surplus bulls	....	....	....	....	....	8,977	17,110	9,619	6,115	3,301
Idle bulls	113	105	172	673	2,632	2,706	2,444	2,239	1,161	747
Young bulls (chiefly 5-year-olds)	199	259	1,658	....	....	....	....	....	....	....
6-year-old males	....	....	....	....	11,167	15,397	13,755	8,991	4,153	3,991
5-year-old males	....	....	....	11,271	15,494	14,813	11,941	5,282	5,007	4,729
4-year-old males	100	2,000	9,939	15,848	15,427	16,631	7,114	5,747	5,667	6,780
3-year-old males	2,000	10,000	13,880	18,282	19,402	19,507	9,117	13,596	10,749	14,668
2-year-old males	11,000	15,000	17,422	23,990	24,169	26,815	30,159	33,081	39,111	41,893
Yearling males	13,000	20,000	23,068	30,307	33,645	38,013	41,595	46,444	51,074	50,249
2-year-old cows	11,000	15,000	17,422	23,990	24,245	26,917	30,415	33,287	39,480	43,419
Yearling cows	13,000	20,000	23,067	30,306	33,646	38,018	41,608	46,447	51,081	54,447
Pups	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172	167,527	176,655
Total	215,738	268,305	294,687	363,872	417,281	468,692	496,432	524,235	552,718	581,443

SPECIMENS FOR SCIENTIFIC PURPOSES.

Upon request of the Colorado Museum of Natural History, Denver, Colo., skins from one adult bull, two cows, and three pups were shipped to the museum. Two of the pups were found dead on St. Paul Island, and the remainder were found dead on St. George Island. The collection was appraised at $39, which was paid by the museum, and the amount in full was deposited in the United States Treasury.

FOXES.

Although the fur seals are the most important feature of the bureau's activities on the Pribilof Islands, the blue-fox herd is rapidly increasing in size and value. When commercial sealing was resumed in 1918 fox food, which had been insufficient during

the close season, was provided in ample quantities. The fox herd immediately began to recuperate, until in the season 1920–21 the total catch amounted to 1,125 blues and 14 white foxes, which brought to the Government the sum of $109,398. With regard to the operations on St. George Island during the season 1920–21, the following extract is quoted from the report of Storekeeper Edward C. Johnston:

Traps.—During the past season foxes were trapped at three places on the island: (*a*) In the large trap on the beach near the village; (*b*) in the wire cage at Zapadni; (*c*) in the village itself by means of string or noose traps. A single unsuccessful attempt was made to take foxes at Garden Cove with string nooses.

In the hope of making the large trap near the village more efficient, a second cage or trap proper was built on the west end of the house, duplicating in size and construction the one on the east end. That our hopes were realized is proved by the fact that on several nights, with both traps operating, every fox caught was captured in the new cage. In the absence of lumber on the station a retaining room was built in the west end of the fox house with heavy wire fencing.

The kench in which it has been customary to place fox food for immediate use was placed entirely outside the fox house, thereby eliminating from the skinning room a very disagreeable stench.

Weather.—The fall and winter of 1920 were exceptionally stormy, and cold weather arrived early. Light snowfall came in September, and in the latter part of November a heavy fall of snow occurred. Beaches also froze up in November. Had it not been necessary to take care of the station supplies landed November 25, trapping could have been commenced a week earlier. Floating ice surrounded the island twice during the season. Fine trapping weather continued until about February 10, 1921, when the mid-winter warm spell, which usually comes early in January, caused the skins to become unprime.

Feeding.—On November 4 the feeding of foxes was started. Twenty seal carcasses (about 500 pounds) proved to be sufficient to satisfy the herd. Thirty carcasses (750 pounds) were put out at various times but were never cleaned up over night. After the trapping was completed about half of the remaining food was placed on the beach and when it had been eaten the rest was cleaned out. There was ample food to last until the migratory birds began to arrive in the spring.

Trapping operations.—Trapping began December 1 and continued until February 25. The first two trappings at the village were made between the hours of 1 and 3 in the afternoon, netting 156 and 155 skins, respectively. The third trapping brought 156 skins in 4 hours (1 to 5 p. m.), and the fourth brought 126 skins in 4½ hours (3 to 7.30 p. m.) and 44 animals were released. In 12½ hours trapping, therefore, 637 animals were caught.

All-night trapping was resorted to only 11 times. During the night trapping a killing was made at midnight. On two nights at Zapadni and one at the village no foxes were caught. On February 9 killing was discontinued on account of unprimeness of the skins. There remained, however, 23 pairs of breeders to secure. By February 25 these were obtained.

Low tides and south winds were responsible for the small catches. A low tide at night, provided foxes can reach the beach, will uncover sufficient sea food to keep the foxes from seeking food in the traps. A southerly wind blowing offshore from the trap carries the scent of food away from the land and causes a small catch. An east or northeast wind is most desired for trapping on St. George Island.

A trial of one night was made to catch foxes at Garden Cove but without success. The trap at Zapadni did not meet expectations. In 21 nights of trapping there 39 foxes were killed and 28 released for breeding purposes—a total of 67—which is just one-half the number handled last season in 20 nights. The fox food at Zapadni must necessarily be put out unfreshened. The writer spent a night at Zapadni and saw foxes enter the trap, sniff at the meat, and go away without touching it. The only fresh water available in winter is melted ice or snow. The large catch at Zapadni in 1920 may have been due to the fact that in the fall of that year a whale was washed ashore there, attracting to that vicinity of the island large numbers of foxes which probably frequented that place during the rest of the winter.

String traps were used in the village at various times, netting about 80 foxes. These foxes very seldom go to the large trap on the beach.

The present building in which the fox skins are cleaned, stretched, and dried will permit but 156 skins to be handled at one time. When trapping conditions are good,

therefore, the catch must be limited to that number. The construction of the new shop which will soon be completed provides large space for the handling and care of fox skins. With ample room to take care of a large number of skins it should be possible to secure most of the catch early in the season and to take full advantage of any good trapping period. The results should be better skins, less night trapping, and, in seasons when warm weather occurs in January, a larger catch.

Weights.—The maximum weights of blue foxes killed was 22 pounds for the males and 19 pounds for the females. The average weight was 12.77 pounds for the males and 9.92 pounds for the females. The maximum weights of blue foxes released for breeding purposes was 28 pounds for the males and 18 pounds for the females. The average weight was 14.04 pounds for the males and 11.22 pounds for the females. Of all animals caught the average weight for males was 13.17 pounds and for females 10.35 pounds. The average weight of all classes was 11.79 pounds.

Breeding reserve.—In selecting breeders attention was first paid to the color and condition of the fur. Middle-aged animals were released in preference to the very old or very young, provided they were in good physical condition. Minimum weights for released animals were set at 11 pounds for the males and 8½ pounds for the females. Unless the foxes near these weights were exceptionally fine they were killed.

Two hundred and forty pairs plus two males were released. As it is the intention to increase the breeding reserve as far as possible, there should be released during the season 1921–22 at least 260 pairs. With the present supply of food, sufficient breeding foxes could be maintained on the island to produce at least 1,500 skins. About 2,000 seal carcasses were sufficient for the foxes in the past season.

It is recommended that the breeding reserve to be released during the season 1921–22 be not less than 260 pairs.

TRAPPING SEASON OF 1921–22.

During the season of 1921–22 a total of 712 blue foxes and 21 white foxes were killed. Of this number 138 blues and 21 whites were taken on St. Paul Island and the remaining 574 blues on St. George Island. There were reserved on St. George Island 231 males and 221 females for breeding purposes. The total number handled on both islands was 1,185 animals. Trapping conditions on St. George Island were poor. Warm weather and exceptionally high seas combined to provide such a large amount of beach food that the animals could not be induced to come to the trap. The unfavorable weather conditions undoubtedly also affected adversely the take on St. Paul Island.

SALE OF LIVE FOXES.

In accordance with arrangements made by the Bureau of Biological Survey during the summer of 1921 four pairs of live blue foxes from St. George Island were delivered in September to Donald H. Stevenson, fur warden of that bureau at Unalaska, as agent for purchasers who desired to stock islands which they held under lease in the Aleutian Islands Reservation. Those obtaining foxes were as follows: L. A. Lavigne, lessee of Unalga Island, one pair; Unalaska Native Brotherhood, lessees of Avatanak Island, one pair; and N. E. Bolshanin, lessee of Kavalga and other islands, two pairs. The purchasers supplied shipping cases, and transportation was furnished by the Coast Guard cutter *Bear* at the risk of purchasers. All the animals were received at Unalaska in good order and were promptly placed on the islands under lease. Sales were made at the rate of $88.12, the average price received at the last preceding sale of Pribilof fox skins. Out of the proceeds the natives were paid a total of $40, or $5 each for labor in securing the eight animals. The net proceeds of $664.96 were turned into the United States Treasury.

FIG. 18.—BLUE FOXES ON ST. GEORGE ISLAND.

FIG. 19.—A SEASON'S TAKE OF BLUE FOX SKINS ON ST. GEORGE ISLAND.

REINDEER.

The 40 reindeer that were brought to the Pribilof Islands in August, 1911, to provide a source of fresh meat for the Government employees and natives have increased to over 400 animals, an average annual increase of over 25 per cent. The herds have become so large and wild that it is difficult to make an accurate count of the different classes of animals. A conservative estimate at the end of the calendar year 1921 showed that there were 250 animals in the St. Paul herd and 160 animals in the St. George herd. A total of 53 animals was killed for food, 19 of which were used on St. George Island.

Reindeer herd on the Pribilof Islands, 1911–1921.

Year.	St. Paul Island.				St. George Island.				Grand total.	
	Adults.	Fawns.	Total, end of year.	Killed in year.	Adults.	Fawns.	Total, end of year.	Killed in year.	End of year.	Killed in year.
1911	[1] 25		25		[2] 15		15		40	
1912	[3] 23	17	40		[2] 14	11	25		65	
1913	[4] 34	18	52		[5] 25	13	38		90	
1914	[6] 51	24	75		[7] 37	21	58		133	
1915	65	27	92		44	18	62		154	
1916			111		54	31	85	2	196	2
1917	105	39	144		70	26	96	3	240	3
1918	120	40	160	2			114	18	274	20
1919			164	14			123	22	287	36
1920			192	22			125	31	317	53
1921			250	34			160	19	410	53

[1] 21 females.
[2] 12 females.
[3] 20 females.
[4] 25 females.
[5] 21 females.
[6] 36 females.
[7] 26 females.

PRIBILOF FUR-SEAL SKINS.

SHIPMENTS.

Three shipments of sealskins were made from the Pribilof Islands in the calendar year 1921. The first of these was made up of 291 skins in 9 barrels from St. Paul Island and 3,295 skins in 74 barrels from St. George Island, these being all of the skins remaining on the islands from the 1920 take. The shipment left the islands June 18 on the U. S. S. *Saturn* and was forwarded from Bremerton, Wash., on July 13 by freight via Northern Pacific to Billings and Chicago, Burlington & Quincy to St. Louis. The shipment was received at its destination July 31.

On August 13 the U. S. S. *Saturn* left the Pribilof Islands with 9,063 skins in 156 barrels from St. Paul Island and 2,207 skins in 45 barrels from St. George Island. The shipment was forwarded from Seattle on August 27 by freight via Northern Pacific to Billings and Chicago, Burlington & Quincy to St. Louis, arriving September 7.

A third shipment was made on the Coast Guard cutter *Bear* September 15, consisting of 9,450 skins in 152 barrels from St. Paul Island and 1,841 skins in 32 barrels from St. George Island. It was forwarded October 6 from Seattle via Northern Pacific to Billings and Chicago, Burlington & Quincy to St. Louis, and arrived October 16.

Six specimen skins were also shipped during the year to the Colorado Museum of Natural History at Denver. Four of these were from St. George Island and were transported on the U. S. S. *Saturn* on its August trip. The other two were from St. Paul Island and were brought down on the Coast Guard cutter *Unalga* in October.

SALES.

Three sales of dressed, dyed, and machined fur-seal skins from the Pribilof Islands were held in St. Louis, Mo., during the calendar year 1921. In all, 30,958 skins were sold at auction for $1,049,176. The table below gives the details regarding the prices secured for each lot of skins at each of the sales, and the table on page 70 is a summary showing the prices obtained for the skins in the various trade classes and the percentages which the number of skins in these several classes bore to the totals in each sale.

February 21, 1921.—At the first sale 10,120 skins were sold at auction for $355,689. The highest price received was for a lot of 60 skins which brought $61 each. The average price obtained was $35.15, a decrease of 52 per cent as compared with the last previous sale, May 10, 1920.

May 23, 1921.—At the May sale 10,060 skins were sold for $359,715. The highest price received was for a lot of 60 skins which brought $58 each. The average price obtained was $35.76, an increase of $1\frac{3}{4}$ per cent over the February sale.

September 28, 1921.—At the September sale 10,778 skins were sold for $333,772. The highest price received was for a lot of 60 skins which brought $55.50 each. The average price obtained was $30.97, a decrease of 13 per cent as compared with the May sale. At this sale an accumulation of 700 "culls and rejects" was disposed of. These skins were obtained largely from the killings of large surplus bulls whose skins had been cut and scarred by fighting on the rookeries. They brought an average of $1.68 each. The low average of all skins sold is accounted for by the inclusion of the "culls and rejects" in the figures.

Sales of dressed, dyed, and machined Pribilof fur-seal skins at St. Louis, Mo., 1921.

SALE OF 10,120 SKINS, FEBRUARY 21, 1921.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$60.00	$3,000.00	14	80	Large	$49.00	$3,920.00
2	50	....do	58.00	2,900.00	15	80	....do	48.00	3,840.00
3	50	Wigs; cut,			16	80	....do	49.00	3,920.00
		scarred, etc.	37.00	1,850.00	17	80	....do	46.00	3,680.00
4	60	Extra extra			18	80	....do	46.00	3,680.00
		large	56.00	3,360.00	19	80	....do	47.00	3,760.00
5	60	....do	61.00	3,660.00	20	80	....do	47.00	3,760.00
6	60	Extra extra			21	80	Large; cut,		
		large; cut,					scarred, etc.	27.50	2,200.00
		scarred, etc.	41.00	2,460.00	22	80	....do	27.00	2,160.00
7	70	Extra large	55.00	3,850.00	23	80	....do	28.50	2,280.00
8	70	....do	54.00	3,780.00	24	80	....do	29.00	2,320.00
9	70	....do	57.00	3,990.00	25	90	Mediums	39.50	3,555.00
10	70	....do	54.00	3,780.00	26	90	....do	40.00	3,600.00
11	70	Extra large;			27	90	....do	42.00	3,780.00
		cut, scarred,			28	90	....do	39.50	3,555.00
		etc.	31.00	2,170.00	29	90	....do	40.00	3,600.00
12	80	Large	52.00	4,160.00	30	90	....do	40.00	3,600.00
13	80	....do	51.00	4,080.00	31	90	....do	40.50	3,645.00

Sales of dressed, dyed, and machined Pribilof fur-seal skins at St. Louis, Mo., 1921—Continued.

SALE OF 10,120 SKINS, FEBRUARY 21, 1921—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skins.	Total for lot.
32	90	Mediums; cut, scarred, etc.	$30.00	$2,700.00
33	90	....do	29.00	2,610.00
34	90	....do	29.00	2,610.00
35	60	Small mediums	36.00	2,160.00
36	40	Small mediums; cut, scarred, etc.	27.00	1,080.00
37	50	III wigs	21.00	1,050.00
38	50	....do	16.50	825.00
39	50	....do	17.00	850.00
40	50	....do	19.50	975.00
41	70	III—45 extra extra large, 25 extra large	20.50	1,435.00
42	80	III large	19.00	1,520.00
43	60	III—50 mediums, 10 small mediums	20.00	1,200.00
44	50	IV wigs	10.00	500.00
45	50	....do	7.50	375.00
46	50	....do	8.00	400.00
47	50	....do	10.00	500.00
48	50	....do	9.50	475.00
49	50	....do	9.00	450.00
51	50	Wigs	55.50	2,775.00
52	50	....do	55.00	2,750.00
53	50	....do	55.00	2,750.00
54	50	....do	56.00	2,800.00
55	32	....do	55.00	2,750.00
56	50	Wigs; cut, scarred, etc.	35.00	1,750.00
57	50	....do	32.00	1,600.00
58	60	Extra extra large	51.00	3,060.00
59	60	....do	50.50	3,030.00
60	60	....do	48.00	2,880.00
61	60	....do	50.00	3,000.00
62	60	....do	50.00	3,000.00
63	60	....do	48.50	2,910.00
64	60	....do	47.00	2,820.00
65	60	....do	47.50	2,850.00
66	60	....do	47.50	2,850.00
67	60	....do	47.50	2,850.00
68	60	....do	51.50	3,090.00
69	60	....do	51.50	3,090.00
70	38	....do	54.00	2,052.00
71	38	....do	55.00	2,090.00
72	60	Extra extra large; cut, scarred, etc.	30.50	1,830.00
73	60	....do	30.50	1,830.00
74	60	....do	29.50	1,770.00
75	60	....do	31.50	1,890.00
76	60	....do	29.50	1,770.00
77	30	....do	32.50	975.00
78	70	Extra large	49.00	3,430.00
79	70	....do	48.00	3,360.00
80	70	....do	49.00	3,430.00
81	70	....do	51.50	3,605.00
82	70	....do	50.00	3,500.00
83	70	....do	51.50	3,605.00
84	70	....do	50.50	3,535.00
85	70	....do	55.00	3,850.00
86	70	....do	54.00	3,780.00
87	53	....do	53.50	2,835.50
88	70	Extra large; cut, scarred, etc.	26.00	1,820.00
89	70	....do	27.00	1,890.00
90	70	....do	29.00	2,030.00
91	70	....do	31.00	2,170.00
92	70	....do	31.00	2,170.00
93	70	....do	31.00	2,170.00
94	48	....do	31.00	1,488.00
95	80	Large	$48.00	$3,840.00
96	80	....do	50.00	4,000.00
97	80	....do	49.00	3,920.00
98	80	....do	50.00	4,000.00
99	80	....do	49.50	3,960.00
100	80	....do	50.50	4,040.00
101	80	....do	50.00	4,000.00
102	80	....do	49.50	3,960.00
103	80	....do	50.00	4,000.00
104	50	....do	50.00	2,500.00
105	36	....do	51.50	1,854.00
106	80	Large; cut, scarred, etc.	27.50	2,200.00
107	80	....do	28.00	2,240.00
108	80	....do	30.00	2,400.00
109	80	....do	30.00	2,400.00
110	80	....do	29.00	2,320.00
111	80	....do	28.50	2,280.00
112	80	....do	29.50	2,360.00
113	80	....do	30.00	2,400.00
114	80	....do	29.50	2,360.00
115	79	....do	28.50	2,251.50
116	90	Mediums	40.50	3,645.00
117	90	....do	41.00	3,690.00
118	90	....do	40.00	3,600.00
119	90	....do	42.00	3,780.00
120	90	....do	41.00	3,690.00
121	52	....do	41.00	2,132.00
122	90	Mediums; cut, scarred, etc.	23.50	2,115.00
123	90	....do	27.00	2,430.00
124	90	....do	27.50	2,475.00
125	90	....do	26.50	2,385.00
126	74	....do	26.00	1,924.00
127	63	Small mediums	37.00	2,331.00
128	72	Small mediums; cut, scarred, etc.	20.50	1,476.00
129	50	III wigs	16.50	825.00
130	50	....do	16.50	825.00
131	50	....do	12.50	625.00
132	50	....do	12.50	625.00
133	50	....do	12.50	625.00
134	50	....do	12.50	625.00
135	60	III extra extra large	13.50	810.00
136	60	....do	14.00	840.00
137	60	....do	14.00	840.00
138	40	....do	14.00	560.00
139	70	III extra large	13.50	945.00
140	62	....do	14.00	868.00
141	80	III large	12.50	1,000.00
142	50	....do	11.50	575.00
143	44	....do	12.00	528.00
144	90	III mediums	12.00	1,080.00
145	60	....do	13.50	810.00
146	52	....do	13.50	702.00
147	27	III small mediums	13.00	351.00
148	50	IV wigs	7.50	375.00
149	50	....do	7.00	350.00
150	30	....do	8.50	255.00
151	32	....do	7.00	224.00
152	56	IV—41 extra extra large, 15 extra large	8.50	476.00
153	60	IV—23 large, 37 mediums	7.50	450.00
154	51	IV—16 mediums, 35 small mediums	7.00	357.00
155	21	Skins	4.00	84.00
	10,120		....	355,689.00

Sales of dressed, dyed, and machined Pribilof fur-seal skins at St. Louis, Mo., 1921—Continued.

SALE OF 10,060 SKINS, MAY 23, 1921.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$46.00	$2,300.00
2	50	.....do	42.00	2,100.00
3	50	.....do	42.00	2,100.00
4	50	.....do	41.00	2,050.00
5	50	.....do	44.00	2,200.00
6	50	.....do	45.00	2,250.00
7	50	.....do	45.00	2,250.00
8	50	.....do	43.00	2,150.00
9	50	.....do	42.00	2,100.00
10	50	.....do	45.00	2,250.00
11	50	.....do	47.00	2,350.00
12	50	.....do	46.00	2,300.00
13	50	.....do	46.00	2,300.00
14	50	.....do	47.00	2,350.00
15	50	Wigs; cut, scarred, etc	28.00	1,400.00
16	50	.....do	29.00	1,450.00
17	50	.....do	27.00	1,350.00
18	50	.....do	26.00	1,300.00
19	50	.....do	26.00	1,300.00
20	50	.....do	26.00	1,300.00
21	50	.....do	28.00	1,400.00
22	50	.....do	28.00	1,400.00
23	50	.....do	28.00	1,400.00
24	50	.....do	28.00	1,400.00
25	50	.....do	28.00	1,400.00
26	50	.....do	28.00	1,400.00
27	50	.....do	29.00	1,450.00
28	50	.....do	30.00	1,500.00
29	60	Extra extra large	54.00	3,240.00
30	60	.....do	56.00	3,360.00
31	60	.....do	53.00	3,180.00
32	60	.....do	55.00	3,300.00
33	60	.....do	56.00	3,360.00
34	60	.....do	56.00	3,360.00
35	60	.....do	56.00	3,360.00
36	60	.....do	58.00	3,480.00
37	60	.....do	57.00	3,420.00
38	60	.....do	56.00	3,360.00
39	60	Extra extra large; cut, scarred, etc	34.00	2,040.00
40	60	.....do	35.00	2,100.00
41	60	.....do	37.00	2,220.00
42	60	.....do	37.00	2,220.00
43	70	Extra large	48.00	3,360.00
44	70	.....do	48.00	3,360.00
45	70	.....do	50.00	3,500.00
46	70	.....do	50.00	3,500.00
47	70	.....do	49.00	3,430.00
48	70	.....do	49.00	3,430.00
49	70	.....do	49.00	3,430.00
50	70	.....do	50.00	3,500.00
51	70	.....do	51.00	3,570.00
52	70	.....do	52.00	3,640.00
53	70	Extra large; cut, scarred, etc	33.50	2,345.00
54	70	.....do	34.50	2,415.00
55	70	.....do	35.00	2,450.00
56	70	.....do	36.00	2,520.00
57	80	Large	41.00	3,280.00
58	80	.....do	42.00	3,360.00
59	80	.....do	42.00	3,360.00
60	80	.....do	43.00	3,440.00
61	80	.....do	43.00	3,440.00
62	80	.....do	42.00	3,360.00
63	80	.....do	42.00	3,360.00
64	80	.....do	43.00	3,440.00
65	80	.....do	43.00	3,440.00
66	80	.....do	43.00	3,440.00
67	80	.....do	44.00	3,520.00
68	80	.....do	44.00	3,520.00
69	80	.....do	44.00	3,520.00
70	80	.....do	43.00	3,440.00
71	80	.....do	43.00	3,440.00
72	80	.....do	45.00	3,600.00
73	80	.....do	45.50	3,640.00
74	80	.....do	44.00	3,520.00

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
75	80	Extra large, cut, scarred, etc	$44.00	$3,520.00
76	80	.....do	44.00	3,520.00
77	80	.....do	44.50	3,560.00
78	80	.....do	44.00	3,520.00
79	80	.....do	45.00	3,600.00
80	80	.....do	44.00	3,520.00
81	80	Large; cut, scarred, etc	34.00	2,720.00
82	80	.....do	34.00	2,720.00
83	80	.....do	33.50	2,680.00
84	80	.....do	34.00	2,720.00
85	80	.....do	33.50	2,680.00
86	80	.....do	34.00	2,720.00
87	80	.....do	34.00	2,720.00
88	80	.....do	36.50	2,920.00
89	80	.....do	35.50	2,840.00
90	80	.....do	36.00	2,880.00
91	80	.....do	35.50	2,840.00
92	90	Mediums	37.00	3,330.00
93	90	.....do	36.00	3,240.00
94	90	.....do	34.00	3,060.00
95	90	.....do	34.00	3,060.00
96	90	.....do	34.50	3,105.00
97	90	.....do	35.00	3,150.00
98	90	.....do	34.50	3,105.00
99	90	.....do	34.00	3,060.00
100	90	.....do	35.00	3,150.00
101	90	.....do	33.50	3,015.00
102	90	.....do	34.50	3,105.00
103	90	.....do	35.00	3,150.00
104	90	.....do	35.50	3,195.00
105	90	.....do	33.00	2,970.00
106	90	.....do	33.50	3,015.00
107	90	.....do	33.50	3,015.00
108	90	.....do	33.50	3,015.00
109	90	.....do	33.50	3,015.00
110	90	.....do	33.00	2,970.00
111	90	.....do	33.00	2,970.00
112	90	.....do	33.00	2,970.00
113	90	Mediums; cut, scarred, etc	27.00	2,430.00
114	90	.....do	27.50	2,475.00
115	90	.....do	27.00	2,430.00
116	90	.....do	28.50	2,565.00
117	90	.....do	27.50	2,475.00
118	90	.....do	27.50	2,475.00
119	90	.....do	28.50	2,565.00
120	90	.....do	28.50	2,565.00
121	90	.....do	28.50	2,565.00
122	90	Small mediums	27.00	2,430.00
123	90	.....do	28.00	2,520.00
124	70	.....do	30.00	2,100.00
125	80	Small mediums; cut, scarred, etc	25.00	2,000.00
126	50	III wigs	12.50	625.00
127	50	.....do	16.00	800.00
128	50	.....do	13.50	675.00
129	50	.....do	13.00	650.00
130	50	.....do	13.00	650.00
131	50	.....do	13.00	650.00
132	50	.....do	13.00	650.00
133	50	.....do	13.50	675.00
134	50	.....do	13.50	675.00
135	50	.....do	13.50	675.00
136	50	.....do	13.50	675.00
137	50	.....do	13.50	675.00
138	70	III—20 extra large, 50 large	24.50	1,715.00
139	90	III mediums	18.50	1,665.00
140	50	IV wigs	4.50	225.00
141	50	.....do	4.50	225.00
142	50	.....do	5.50	275.00
143	50	.....do	5.50	275.00
144	50	.....do	5.00	250.00
	10,060			359,715.00

Sales of dressed, dyed, and machined Pribilof fur-seal skins at St. Louis, Mo., 1921—Continued.

SALE OF 10,778 SKINS, SEPTEMBER 28, 1921.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$36.00	$1,800.00
2	50	do	35.00	1,750.00
3	50	do	39.00	1,950.00
4	50	do	36.00	1,800.00
5	50	do	38.00	1,900.00
6	50	do	36.00	1,800.00
7	50	do	39.00	1,950.00
8	50	do	37.00	1,850.00
9	50	do	35.00	1,750.00
10	50	do	38.00	1,900.00
11	50	do	39.00	1,950.00
12	50	do	41.00	2,050.00
13	50	do	38.00	1,900.00
14	50	do	39.00	1,950.00
15	50	Wigs, cut	23.00	1,150.00
16	50	do	23.00	1,150.00
17	50	do	23.00	1,150.00
18	50	do	25.00	1,250.00
19	50	do	25.00	1,250.00
20	50	do	24.50	1,225.00
21	50	do	25.50	1,275.00
22	50	do	26.00	1,300.00
23	50	do	27.50	1,375.00
24	50	do	25.00	1,250.00
25	50	do	27.00	1,350.00
26	50	do	27.00	1,350.00
27	60	Extra extra large	54.00	3,240.00
28	60	do	52.00	3,120.00
29	60	do	54.00	3,240.00
30	60	do	52.00	3,120.00
31	60	do	54.50	3,270.00
32	60	do	54.00	3,240.00
33	60	do	55.50	3,330.00
34	60	do	55.00	3,300.00
35	60	do	55.00	3,300.00
36	30	do	53.00	1,590.00
37	60	Extra extra large, cut	33.00	1,980.00
38	60	do	34.50	2,070.00
39	60	do	36.00	2,160.00
40	60	do	36.50	2,190.00
41	70	Extra large	42.50	2,975.00
42	70	do	43.00	3,010.00
43	70	do	44.50	3,115.00
44	70	do	43.50	3,045.00
45	70	do	45.50	3,185.00
46	70	do	44.00	3,080.00
47	70	do	48.00	3,360.00
48	70	do	46.00	3,220.00
49	70	do	47.00	3,290.00
50	70	do	49.00	3,430.00
51	70	do	46.50	3,255.00
52	70	do	47.50	3,325.00
53	70	do	47.50	3,325.00
54	50	do	46.00	2,300.00
55	70	Extra large, cut	34.00	2,380.00
56	70	do	33.50	2,345.00
57	70	do	34.00	2,380.00
58	70	do	33.50	2,345.00
59	70	do	34.50	2,415.00
60	80	Large	42.50	3,400.00
61	80	do	41.00	3,280.00
62	80	do	42.50	3,400.00
63	80	do	41.00	3,280.00
64	80	do	39.50	3,160.00
65	80	do	40.00	3,200.00
66	80	do	41.00	3,280.00
67	80	do	39.00	3,120.00
68	80	do	39.00	3,120.00
69	80	do	38.00	3,040.00
70	80	do	39.00	3,120.00
71	80	do	40.50	3,240.00
72	80	do	38.50	3,080.00
73	80	do	38.00	3,040.00
74	80	do	38.00	3,040.00
75	80	do	37.50	3,000.00
76	80	do	39.00	3,120.00
77	80	do	39.00	3,120.00
78	80	Large	$37.50	$3,000.00
79	80	do	37.50	3,000.00
80	80	do	37.50	3,000.00
81	80	do	38.00	3,040.00
82	80	do	39.00	3,120.00
83	80	do	38.00	3,040.00
84	80	do	38.00	3,040.00
85	80	do	43.00	3,440.00
86	40	do	39.00	1,560.00
87	80	Large, cut	30.00	2,400.00
88	80	do	30.00	2,400.00
89	80	do	30.00	2,400.00
90	80	do	30.00	2,400.00
91	80	do	31.50	2,520.00
92	80	do	31.50	2,520.00
93	80	do	31.00	2,480.00
94	80	do	31.00	2,480.00
95	80	do	31.50	2,520.00
96	80	do	31.50	2,520.00
97	80	do	31.00	2,480.00
98	80	do	31.50	2,520.00
99	60	do	30.50	1,830.00
100	90	Mediums	31.00	2,790.00
101	90	do	30.00	2,700.00
102	90	do	30.50	2,745.00
103	90	do	30.00	2,700.00
104	90	do	30.50	2,745.00
105	90	do	30.00	2,700.00
106	90	do	30.00	2,700.00
107	90	do	29.50	2,655.00
108	90	do	29.00	2,610.00
109	90	do	29.00	2,610.00
110	90	do	28.00	2,520.00
111	90	do	29.50	2,655.00
112	90	do	30.00	2,700.00
113	90	do	30.00	2,700.00
114	90	do	29.50	2,655.00
115	90	do	30.00	2,700.00
116	90	Mediums, cut	22.00	1,980.00
117	90	do	22.00	1,980.00
118	90	do	22.00	1,980.00
119	90	do	22.50	2,025.00
120	90	do	22.00	1,980.00
121	90	do	22.00	1,980.00
122	90	do	22.00	1,980.00
123	90	do	22.00	1,980.00
124	90	do	22.50	2,025.00
125	90	do	23.50	2,115.00
126	60	Small mediums	26.00	1,560.00
127	60	do	27.00	1,620.00
128	90	Small mediums, cut	20.00	1,800.00
129	50	III wigs	16.00	800.00
130	50	do	15.50	775.00
131	50	do	15.00	750.00
132	50	do	14.50	725.00
133	50	do	15.50	775.00
134	50	do	16.00	800.00
135	50	do	15.50	775.00
136	50	do	15.00	750.00
137	50	do	15.50	775.00
138	50	do	16.00	800.00
139	50	do	16.00	800.00
140	50	do	16.50	825.00
141	44	III—14 extra extra large, 30 extra large	20.00	880.00
142	58	III large	16.50	957.00
143	66	III mediums	15.00	990.00
144	50	IV wigs	8.00	400.00
145	50	do	8.00	400.00
146	50	do	6.50	325.00
147	50	do	7.00	350.00
149	250	Culls and rejects	2.00	500.00
149A	250	do	2.10	525.00
149B	100	do	1.00	100.00
149C	100	do	.50	50.00
	10,778			333,772.00

Comparative values by sizes and grades with percentages each size, of Pribilof sealskins sold in 1921.

Classes and sales.	Grade.	Number.	High.	Low.	Average.	Total.	Total number.	Average.	Total price.	Percentage.
Wigs:										
Feb. 21	I and II	332	$60.00	$55.00	$56.43	$18,735.00	1,444	$24.72	$35,689.00	14.27
	Cut, etc.	150	37.00	32.00	34.67	5,200.00				
	III	500	21.00	12.50	15.70	7,850.00				
	IV	462	10.00	7.00	8.45	3,904.00				
May 23	I and II	700	47.00	41.00	44.36	31,050.00	2,250	26.59	59,825.00	22.37
	Cut, etc.	700	30.00	26.00	27.79	19,450.00				
	III	600	16.00	13.00	13.46	8,075.00				
	IV	250	5.50	4.50	5.00	1,250.00				
Sept. 28	I and II	700	41.00	35.00	37.57	26,300.00	2,100	24.86	52,200.00	19.49
	Cut	600	27.50	23.00	25.12	15,075.00				
	III	600	16.50	14.50	15.59	9,350.00				
	IV	200	8.00	6.50	7.38	1,475.00				
Extra extra large:										
Feb. 21	I and II	916	61.00	47.00	50.86	46,592.00	1,612	39.35	63,438.00	15.93
	Cut, etc.	390	41.00	29.45	32.12	12,525.00				
	III	265	20.50	13.50	14.99	3,972.50				
	IV	41	8.50	8.50	8.50	348.50				
May 23	I and II	600	58.00	53.00	55.70	33,420.00	840	50.00	42,000.00	8.35
	Cut, etc.	240	37.00	34.00	35.75	8,580.00				
Sept. 28	I and II	570	55.50	52.00	53.95	30,750.00	824	47.85	39,430.00	7.65
	Cut	240	36.50	33.00	35.00	8,400.00				
	III	14	20.00	20.00	20.00	280.00				
Extra large:										
Feb. 21	I and II	963	57.00	48.00	52.26	50,330.50	1,673	41.06	68,691.50	16.53
	Cut, etc.	538	31.00	26.00	29.57	15,908.00				
	III	157	20.50	13.50	14.81	2,325.50				
	IV	15	8.50	8.50	8.50	127.50				
May 23	I and II	700	52.00	48.00	49.60	34,720.00	1,000	44.94	44,940.00	9.94
	Cut, etc.	280	36.00	33.50	34.75	9,730.00				
	III	20	24.50	24.50	24.50	490.00				
Sept. 28	I and II	960	49.00	42.50	45.74	43,915.00	1,340	41.33	56,380.00	12.43
	Cut	350	34.50	33.50	33.90	11,865.00				
	III	30	20.00	20.00	20.00	600.00				
Large:										
Feb. 21	I and II	1,526	52.00	46.00	49.07	74,874.00	2,922	37.93	110,841.00	28.87
	Cut, etc.	1,119	30.00	27.00	28.76	32,171.50				
	III	254	19.00	11.50	14.26	3,623.00				
	IV	23	7.50	7.50	7.50	172.50				
May 23	I and II	1,920	45.50	41.00	43.42	83,360.00	2,850	40.36	115,025.00	28.33
	Cut, etc.	880	36.50	33.50	34.59	30,440.00				
	III	50	24.50	24.50	24.50	1,225.00				
Sept. 28	I and II	2,120	43.00	37.50	39.28	83,280.00	3,198	36.18	115,707.00	29.67
	Cut	1,020	31.50	30.00	30.85	31,470.00				
	III	58	16.50	16.50	16.50	957.00				
Mediums:										
Feb. 21	I and II	1,132	42.00	39.50	40.52	45,872.00	2,141	32.28	69,102.50	21.16
	Cut, etc.	704	30.00	26.00	27.34	19,249.00				
	III	252	20.00	12.00	14.25	3,592.00				
	IV	53	7.50	7.00	7.35	389.50				
May 23	I and II	1,890	37.00	33.00	34.22	64,665.00	2,790	31.85	88,875.00	27.73
	Cut, etc.	810	28.50	27.00	27.83	22,545.00				
	III	90	18.50	18.50	18.50	1,665.00				
Sept. 28	I and II	1,440	31.00	28.00	29.78	42,885.00	2,406	26.56	63,900.00	22.32
	Cut	900	23.50	22.00	22.25	20,025.00				
	III	66	15.00	15.00	15.00	990.00				
Small mediums:										
Feb. 21	I and II	123	37.00	36.00	36.51	4,491.00	307	25.55	7,843.00	3.03
	Cut, etc.	112	27.00	20.50	22.82	2,556.00				
	III	37	20.00	13.00	14.89	551.00				
	IV	35	7.00	7.00	7.00	245.00				
May 23	I and II	250	30.00	27.00	28.20	7,050.00	330	27.44	9,050.00	3.28
	Cut, etc.	80	25.00	25.00	25.00	2,000.00				
Sept. 28	I and II	120	27.00	26.00	26.50	3,180.00	210	23.71	4,980.00	1.95
	Cut	90	20.00	20.00	20.00	1,800.00				
Odd skins:										
Feb 21		21	4.00	4.00	4.00	84.00	21	4.00	84.00	.21
Culls and rejects:										
Sept. 28		700	2.10	.50	1.68	1,175.00	700	1.68	1,175.00	6.49
All classes:										
Feb. 21							10,120	35.15	355,689.00	100.00
May 23							10,060	35.76	359,715.00	100.00
Sept. 28							10,778	30.97	333,772.00	100.00
All sales							30,958	33.89	1,049,176.00	100.00

DISPOSITION OF ALL SKINS.

As in the published report for the preceding calendar year, a statement of the number of fur-seal skins handled during the year and the number on hand, both at the Pribilof Islands and at St. Louis, at the end of the calendar year 1921 is given in the tables below. The grand total of skins on hand December 31, 1921, was 53,877.

PRIBILOF RECORD.

A brief record of all fur-seal skins handled on the Pribilof Islands during 1921, showing the balance on hand December 31, is given in the following table:

Disposition of all fur-seal skins handled on Pribilof Islands, calendar year 1921.

	Balance on hand, Jan. 1.	Number taken.	Total handled.	Number shipped.	Balance on hand, Dec. 31.
St. Paul Island	291	19,230	19,521	18,804	717
St. George Island	3,295	4,451	7,746	7,343	403
Total	3,586	23,681	27,267	26,147	1,120

ST. LOUIS RECORD, FOUKE FUR CO.

In the preceding annual report there was published a summary showing shipments of skins, sales, and balances remaining in the hands of the department's selling agents, Funsten Bros. & Co., St. Louis, Mo. Early in the year 1921 the contract with Funsten Bros. & Co. was canceled and a new one entered into with the Fouke Fur Co. The 57,612 fur-seal skins then in the possession of Funsten Bros. & Co. were delivered to the Fouke Fur Co. The following table shows receipts and sales of skins by the firm during the calendar year 1921:

Summary of receipts and sales of Pribilof fur-seal skins by Fouke Fur Co., St. Louis, Mo., and balance in firm's custody, calendar year 1921.

Date of shipment from Pribilofs.	Receipts.		Sales.		Balance on hand.
	Date.	Number of skins.	Date.	Number of skins.	
					57,612
			Feb. 21	10,120	47,492
			Mar. 19	44	47,448
			May 23	10,060	37,388
June 18	July 31	3,586			40,974
Aug. 13	Sept. 7	11,270			52,244
Sept. 15	Oct. 16	11,291			63,535
			Sept. 28	10,778	52,757
Total		26,147		31,002	[1] 52,757

[1] Seven of these skins were held at the Washington office for exhibition purposes.

PRIBILOF FOX SKINS.

SHIPMENTS.

The fox skins taken in the season of 1920–21 were forwarded in one shipment of 3 boxes containing 123 blue and 13 white skins from St. Paul Island and 24 boxes containing 1,002 blue and 1 white fox skin from St. George Island. They were forwarded on June 18 on the U. S. S. *Saturn* along with the first shipment of sealskins from the islands. The whole shipment of fox skins, totaling 1,139, was sent by express from Bremerton, Wash., on July 12, via Chicago, Burlington & Quincy, and was received at St. Louis on July 18.

SALES.

The fox skins taken on the Pribilof Islands in the season of 1919–20, 938 in number, were not sold until February 21, 1921. At the public auction at St. Louis on that date 901 blue fox skins brought $79,404, an average of $88.13 per skin, and the 37 white fox skins brought $1,295, and average of $35 each. The highest price received was for a lot of 4 skins, which brought $192 each. The average price received for blues at this sale showed a decrease of 55 per cent as compared with the last previous sale on September 10, 1919, when the average price was $195 and the highest price was for a lot of 4 skins which brought $400 each. Details of both sales are shown in the table below.

The skins taken during the season 1920–21 numbered 1,125 blues and 14 whites. They were sold at auction at St. Louis September 28, 1921, the blues bringing $108,936, an average of $96.83 each, and the whites bringing $462, an average of $33 each. The highest price received was for a lot of 4 skins, which brought $230 each. The average price for the blues was about 10 per cent higher than that of the February sale.

Sales of Pribilof fox skins at St. Louis, Mo., 1921.

SALE OF 901 BLUE AND 37 WHITE FOX SKINS, FEBRUARY 21, 1921

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
		Blue-fox skins.		
9200	4	Extra extra fine	$192.00	$768.00
9201	6	.....do	152.00	912.00
9202	4	Extra extra fine extra large	132.00	528.00
9203	4	Extra fine large	122.00	488.00
9204	6	Extra fine	130.00	780.00
9205	6	Extra large fine	130.00	780.00
9206	12	II fine dark	106.00	1,272.00
9207	6	II extra large fine dark	120.00	720.00
9208	8	I blue	104.00	832.00
9209	10	I extra large dark silvery	160.00	1,600.00
9210	12	I point II dark	132.00	1,584.00
9211	12	I silvery	130.00	1,560.00
9212	6	I pale silvery	102.00	612.00
9213	9	Skins	6.00	54.00
9214	4	Extra extra fine extra large	175.00	700.00
9215	4	Extra extra fine	140.00	560.00
		Blue-fox skins—Continued.		
9216	4	Extra fine	$126.00	$504.00
9217	8	Fine	124.00	992.00
9218	6	Extra large fine	104.00	624.00
9219	12	II fine dark	100.00	1,200.00
9220	12	II blue	84.00	1,008.00
9221	4	Extra extra fine	153.00	612.00
9222	4	.....do	134.00	536.00
9223	6	Extra fine	132.00	792.00
9224	10	I fine dark	112.00	1,120.00
9225	10	I dark	104.00	1,040.00
9226	10	II extra large fine dark	98.00	980.00
9227	12	II fine dark	94.00	1,128.00
9228	14	II extra large dark	82.00	1,148.00
9229	14	II dark	88.00	1,232.00
9230	14	II extra large low	60.00	840.00
9231	8	I blue extra large	108.00	864.00
9232	14	I blue	98.00	1,372.00
9233	12	II extra large blue	81.00	972.00
9234	14	II blue	82.00	1,148.00

Sales of Pribilof fox skins at St. Louis, Mo., 1921—Continued.

SALE OF 901 BLUE AND 37 WHITE FOX SKINS, FEBRUARY 21, 1921—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
		Blue fox-skins—Continued.					*Blue fox-skins*—Continued.		
9235	20	II low blue	$64.00	$1,280.00	9262	23	II low	$58.00	$1,334.00
9236	15	II extra large low	52.00	780.00	9263	26	III point IV	8.00	208.00
9237	10	I dark silvery	148.00	1,480.00	9264	4	Extra extra fine	147.00	588.00
9238	12	I and II silvery	103.00	1,236.00	9265	10	I extra large fine dark	130.00	1,300.00
9239	18	I and II	85.00	1,530.00	9266	10	II dark fine	96.00	960.00
9240	22	III	25.00	550.00	9267	12	do	106.00	1,272.00
9241	4	Extra extra fine	158.00	632.00	9268	17	II dark	92.00	1,564.00
9242	6	Extra fine	122.00	732.00	9269	14	II blue	90.00	1,260.00
9243	8	I dark	110.00	880.00	9270	14	II extra large low	62.00	868.00
9244	12	II extra large dark fine	94.00	1,128.00	9271	8	I fine dark	136.00	1,088.00
9245	14	II dark fine	94.00	1,316.00	9272	4	Extra extra fine	168.00	672.00
9246	12	II extra large dark	82.00	984.00	9273	10	I extra large fine dark	128.00	1,280.00
9247	14	II dark	87.00	1,218.00	9274	10	I fine dark	132.00	1,320.00
9248	16	II low	72.00	1,152.00	9275	10	II dark fine	102.00	1,020.00
9249	10	I blue extra large	101.00	1,010.00	9276	16	II dark	90.00	1,440.00
9250	12	II extra large blue	72.00	864.00	9277	13	II blue	74.00	962.00
9251	14	II blue	84.00	1,176.00	9278	12	I	78.00	936.00
9252	22	II low	46.00	1,012.00	9279	14	II extra large	64.00	896.00
9253	24	III	19.00	456.00	9280	20	II	58.00	1,160.00
9254	4	Extra extra fine	142.00	568.00		901			79,404.00
9255	6	I dark	110.00	660.00			*White-fox skins.*		
9256	10	II dark fine	104.00	1,040.00	9281	37	I and II white fox	35.00	1,295.00
9257	14	do	106.00	1,484.00		938			80,699.00
9258	12	II extra large dark	103.00	1,236.00					
9259	14	II dark	86.00	1,204.00					
9260	14	II low	59.00	826.00					
9261	14	II blue	70.00	980.00					

SALE OF 1,125 BLUE AND 14 WHITE FOX SKINS, SEPTEMBER 28, 1921.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
		Blue-fox skins.					*Blue fox-skins*—Continued.		
150	4	Extra extra fine	$230.00	$920.00	187	10	I fine dark	$150.00	$1,500.00
151	6	Extra fine	150.00	900.00	188	14	I dark	133.00	1,862.00
152	6	Fine dark	145.00	870.00	189	16	II fine dark	112.00	1,792.00
153	6	I fine dark silvery	180.00	1,080.00	190	18	II dark	100.00	1,800.00
154	8	I silvery	160.00	1,280.00	191	14	II low dark	71.00	994.00
155	14	I blue	126.00	1,764.00	192	10	I blue	110.00	1,100.00
156	8	II blue	95.00	760.00	193	14	II blue	94.00	1,316.00
157	6	Silvery	100.00	600.00	194	20	II low	54.00	1,080.00
158	9	Skins	26.00	234.00	195	24	III	37.00	888.00
159	4	Extra extra fine	194.00	776.00	196	4	Extra extra fine	181.00	724.00
160	6	Fine dark	155.00	930.00	197	6	Extra fine	154.00	924.00
161	8	Dark	155.00	1,240.00	198	10	I fine dark	130.00	1,300.00
162	6	II extra dark	135.00	810.00	199	12	I dark	130.00	1,560.00
163	8	I and II blue	125.00	1,000.00	200	14	I dark	120.00	1,680.00
164	6	I dark	145.00	870.00	201	14	Dark	100.00	1,400.00
165	11	Dark	135.00	1,485.00	202	16	II dark	102.00	1,632.00
166	7	I and II blue	120.00	840.00	203	12	II extra large	80.00	960.00
167	4	Extra extra fine	190.00	760.00	204	20	II	66.00	1,320.00
168	4	Extra extra fine extra large	150.00	600.00	205	24	II and II low	56.00	1,344.00
169	4	Extra fine	155.00	620.00	206	35	III and IV	7.00	245.00
170	10	I fine dark	166.00	1,660.00	207	12	I dark	128.00	1,536.00
171	14	I dark	128.00	1,792.00	208	16	II dark	86.00	1,376.00
172	10	Extra dark	132.00	1,320.00	209	10	I blue	112.00	1,120.00
173	12	II fine dark	115.00	1,380.00	210	14	II blue	80.00	1,120.00
174	14	II dark	96.00	1,344.00	211	8	Dark silvery	150.00	1,200.00
175	10	II dark extra large	94.00	940.00	212	16	I	90.00	1,440.00
176	14	II low dark	66.00	924.00	213	16	II	68.00	1,088.00
177	8	Fine blue	140.00	1,120.00	214	24	II low	46.00	1,104.00
178	10	I blue	118.00	1,180.00	215	6	Extra fine	155.00	930.00
179	14	II blue	86.00	1,204.00	216	10	I dark	130.00	1,300.00
180	22	II low	68.00	1,496.00	217	16	II dark	90.00	1,440.00
181	10	I dark silvery	157.50	1,575.00	218	10	I blue	128.00	1,280.00
182	12	Silvery	110.00	1,320.00	219	18	II blue	92.00	1,656.00
183	14	II low	57.00	798.00	220	4	I	94.00	376.00
184	28	III	42.00	1,176.00	221	14	II	66.00	924.00
185	4	Extra extra fine	180.00	720.00	222	8	Fine dark	160.00	1,280.00
186	6	Extra fine	169.00	1,014.00	223	14	I dark	95.00	1,330.00
					224	12	II dark	90.00	1,080.00
					225	8	I extra large	106.00	848.00

Sales of Pribilof fox skins at St. Louis, Mo., 1921—Continued.

SALE OF 1,125 BLUE AND 14 WHITE FOX SKINS, SEPTEMBER 28, 1921—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
		Blue fox-skins—Continued.					*Blue fox-skins*—Continued.		
226	12	II extra large	$96.00	$1,152.00	240	18	I and II	$103.00	$1,854.00
227	10	I	135.00	1,350.00	241	10	II	78.00	780.00
228	18	II	80.00	1,440.00	242	8	Pale	72.00	576.00
229	27	III	17.00	459.00	243	10	I dark	136.00	1,360.00
230	10	I fine dark	137.00	1,370.00	244	14	II	72.00	1,008.00
231	10	I dark	122.00	1,220.00					
232	10	II dark	86.00	860.00		1,125			108,936.00
233	14	Silvery	135.00	1,890.00					
234	4	Extra extra fine	140.00	560.00			*White-fox skins.*		
235	12	I dark	130.00	1,560.00					
236	12	II dark	80.00	960.00	245	14	I and II white fox	33.00	462.00
237	10	II	90.00	900.00					
238	10	I blue	111.00	1,110.00					
239	16	II blue	86.00	1,376.00		1,139			109,398.00

FUR-SEAL PATROL BY UNITED STATES COAST GUARD.

As in previous years a patrol was maintained by vessels of the Coast Guard for the protection of the migrating fur-seal herd and the prevention of illegal pelagic sealing. Four vessels were chiefly engaged in this duty in the season of 1921. The *Snohomish* patrolled the sealing grounds off the coast of Washington during the months of April, May, and June. The *Algonquin* followed the course of the herd through the waters of southeastern Alaska, across to the Aleutian Islands, and patrolled chiefly in Bering Sea. The *Unalga* went direct to Unalaska and maintained a patrol along the Aleutian Islands and in Bering Sea. The *Bear* made its usual Arctic cruise, stopping at the Pribilofs on the return to transport passengers for the bureau and products from the islands. Numerous courtesies in the way of transportation of passengers, mail, and freight for the bureau are gratefully acknowledged. The following extracts are made from a report of the cruises of the Coast Guard cutters while engaged on the seal patrol.

PATROL OF WASHINGTON COAST.

Snohomish.—Since April 15, 1921, the *Snohomish* has been actively engaged in patrolling the waters of the Pacific Ocean between Cape Flattery and the Columbia River and to the westward thereof for the protection of the seal herd. A number of fishing vessels have been boarded and an alert lookout maintained, but no evidence tending to the belief that seals were being taken illegally could be found. During this period of time exhaustive inquiries have been made and conferences held with reliable authorities relative to the probability of illegal sealing being carried on along the section of the coast patrolled and contiguous waters. Chief among the persons consulted in this connection are the following: (1) A. D. Dodge, Indian agent, Neah Bay, Wash., who has charge of the Indian Reservations at Neah Bay, Ozette, and Quillayute, and who is very diligent in safeguarding the rights of the Indians with particular reference to exclusive sealing privileges. (2) H. B. Hobbs, Weather Bureau Observer at Neah Bay, Wash., a former assistant light keeper at Tatoosh and a former member of the crew of the Neah Bay Coast Guard Station. He has lived in the vicinity of Neah Bay and Tatoosh since his birth. (3) W. W. Washburn, for a number of years storekeeper, postmaster, and leading citizen of Neah Bay, who is thoroughly familiar with the Indians and fishermen in that vicinity, their habits,

customs, etc. (4) The school-teacher at Quillayute Indian Village. (5) The light-keeper at Tatoosh Island who has held the position for 25 years or more. (6) The keeper of the Neah Bay Coast Guard Station. (7) A number of the more intelligent Indians at Neah Bay and Quillayute.

The consensus of opinion of the authorities consulted is that no illegal sealing has been carried on this year along the coast of Washington or Vancouver Island. The Indians are very jealous of their exclusive prerogative of taking sealskins and are quick and anxious to report any vessels that they suspicion of taking seals illegally. They seal from their canoes 10 to 25 miles offshore and are therefore in a position to observe any illegal interference with the seal herd. The best price that has been offered by any fur dealer for the skins taken by the Indians is $13 per skin, so that the remuneration for illegal sealing is not sufficiently great to make such operations attractive. This point was emphasized by most of the parties conferred with.

There are about 17 Indian canoes engaged in sealing from the village of Neah Bay, Ozette, and Quillayute. * * * The Indians will cease sealing operations about June 15, as by that time the bulk of the herd will have passed well to the northward.

PATROL OF ALASKA WATERS.

Algonquin.—The *Algonquin* left Neah Bay, Wash., on her Alaska cruise, April 30, 1921, and arrived at Sitka, Alaska, on May 4. On May 6 left Sitka, proceeding as far west as Yakataga Cape, and thence to Ketchikan. At various times during this cruise seals were sighted and three fishing vessels were boarded. On May 18 left Ketchikan and proceeded westward. * * * Arrived at Unalaska on the afternoon of June 13. * * * Throughout the cruise good weather was experienced. No pelagic sealers were encountered.

On June 18 the *Algonquin* left Unalaska for a cruise to the westward as far as Attu. * * * July 14 arrived at Unalaska at 2:40 p. m. * * * No pelagic sealers were sighted during the cruise. * * *

On August 8 the *Algonquin* left Unalaska for a cruise to the Pribilof Islands and reached Village Cove on August 11. She remained at anchor August 12 and 13 to afford the officers and crew opportunity to visit the seal rookeries. On August 14 Mr. and Mrs. Krukof and two children came aboard for transportation to Unalaska. On August 15 left Village Cove, and the same day anchored off North Village, St. George Island, where mail was received and delivered. On August 16 left St. George Island for Unalaska, arriving there on the morning of August 17; passengers and mail were discharged. While on this cruise nothing out of the way was noticed, no suspicious vessels were sighted, and no evidence of pelagic sealing was found. * * *

On August 25, at 11.05 a. m., the *Algonquin*, after taking on board some stores, proceeded to the westward, and at 7.20 p. m. lay to off Bogoslof Island for about 20 minutes. At 7.45 p. m. proceeded to Nikolski, Umnak Island, reaching there on the morning of August 26. After delivering stores left for Atka, arriving on August 27. * * * At 1.15 p. m. left Atka and arrived at Tschicagof Harbor at 7.50 a. m., August 31. * * * On September 1, at 8.05 a. m., left Tschicagof Harbor and anchored off the east end of Alaid Island at 11.55 a. m. * * * At 2 p. m. laid a course for St. Paul Island. Owing to adverse weather conditions it was found impracticable to gain shelter or make landing at the Pribilof Islands; therefore proceeded toward Unalaska, arriving there at 5.35 p. m. September 5. During this cruise no evidence of pelagic sealing was found. * * *

On September 8 the *Algonquin* * * * left Unalaska for Atka, arriving there on the morning of September 10. * * * On September 11 left Atka and arrived at Village Cove, St. Paul Island, at 10 a. m. September 13. At 3.05 p. m. left St. Paul Island and arrived at Unalaska on the afternoon of September 14. While en route from St. Paul Island to Unalaska the motor schooner Chukotsk, trader, was boarded and examined, but no violations were found. * * * No pelagic sealers were sighted on this cruise.

On September 20 the *Algonquin* left Unalaska and arrived at Akutan at 6.05 p. m. the same day. At 9.20 p. m. proceeded, via Unimak Pass, for St. Paul, Kodiak. * * * At 3 p. m. September 26 arrived at St. Paul, Kodiak. On September 27, at 3.55 p. m., sailed for Seattle. * * * On October 2 arrived at Point Wells, received fuel oil, and proceeded to Seattle, arriving there at 6.50 p. m. October 2.

Unalga.—The *Unalga* left Seattle, Wash., April 29, 1921, on her Alaskan cruise. On board the cutter were eight passengers, six of whom were representatives of the Bureau of Fisheries, who desired transportation to Unalaska. * * * On May 1 proceeded on course out of Puget Sound and at 2.40 p. m. May 9 came to anchor off Unga, Alaska. * * * While at this point Mr. Christoffersen, of the Bureau of

Fisheries. made an investigation at the fishing station. * * * On May 12 stood into Unalaska Bay and made fast to the wharf. No pelagic sealers were sighted during this cruise. Delivered mail and discharged passengers.

On May 17 the *Unalga* left Unalaska for a patrol of Unimak Pass to look after the protection of the cannery fleets. * * * On May 21 * * *, at 3 p. m., anchored in King Cove, where J. N. Braun, who was taken aboard at Unalaska, went ashore. * * * On May 22 got under way and stood for the south end of Unimak Pass, Sannak Fishing Banks, and back for Unimak Pass. * * * On the morning of May 24 arrived at Unalaska. At 6 p. m. May 24 the *Unalga* stood for the Slime Banks for the purpose of boarding the codfish fleet and making a patrol of Unimak Pass. * * * May 31 arrived at Unalaska at 4.50 p. m. During this cruise no pelagic sealers were sighted. * * *

On June 6 the *Unalga* left Unalaska for Dutch Harbor to load lumber for delivery to the Bureau of Fisheries, St. George Island. On June 8, with one passenger aboard and with the American schooner *Sequoia* in tow, stood out of the harbor. At 12.45 p. m. let go the *Sequoia* and proceeded toward St. George Island. On June 9 anchored in Garden Cove, St. George Island, to await better weather conditions. On June 10, the fog having lifted, got under way for North Anchorage. It was found, however, that the fog was still too dense to land cargo, so stood back to Garden Cove. At 1 p. m. stood around Tolstoi Point and anchored off the village; delivered 13 boxes for the Russian Church and 2 sacks of mail to the local agent of the Bureau of Fisheries; unloaded lumber; received from the Bureau of Fisheries' agent 2 sacks of outgoing mail. On June 11, the unloading of the lumber being completed, got under way at 11.50 a. m. and arrived at St. Paul Island at 4.45 p. m., where Mrs. Valsa Siftsoff, passenger, left the vessel. The Superintendent of the Pribilof Islands called on the commanding officer of the *Unalga*. The two sacks of mail for St. Paul Island were delivered to the superintendent. On June 12, at 1 p. m., got under way and stood eastward to patrol between St. Paul and Walrus Islands. At 3.20 p. m. anchored to the westward of Walrus Island, and at 5.25 p. m. proceeded back to anchorage at Village Cove, St. Paul Island. On June 13, at 11.18 a. m., got under way and stood out for patrol of the Seal Islands. * * * Set a course for Unalaska, arriving there at 3.30 p. m. June 16. During this cruise no pelagic sealers were sighted. * * *

On June 23, at 11 a. m., the *Unalga* proceeded to Dutch Harbor to take on remainder of lumber and supplies for the Bureau of Fisheries at the Pribilof Islands. The *Unalga*, having taken on board lumber and seven natives who desired transportation to St. Paul Island, got under way at 4.30 p. m. and stood out of Dutch Harbor for St. George Island; anchored off North Anchorage at 2.15 p. m. June 24; unloaded lumber. On June 26, at 6.40 a. m., got under way for St. Paul Island, anchoring in Village Cove at 11.40 a. m. Unloaded freight for the Bureau of Fisheries. The superintendent of the Pribilof Islands came aboard and received four sacks of mail and two packages. One box of radio material was delivered to the naval radio station on the island. The seven natives left the vessel. At 6 p. m. stood for Unimak Island to transfer a naval radio working party at request of commanding officer of the U. S. S. *Saturn*. * * * July 7 stood for Unalaska, where arrived at 12.50 p. m. During this cruise no pelagic sealers were sighted.

At 6.30 a. m. July 10 the *Unalga* proceeded to the patrol of the Bering Sea in the immediate vicinity of the Pribilof Islands. Stopped at St. George Island and received on board a passenger for transportation to St. Paul Island; also took on board mail. At 3.35 p. m. July 13 got under way and stood for St. Paul Island, reaching the east side of village at 8.05 p. m.; landed passenger. From July 15 to 22 patrolled in the vicinity of St. Paul Island, returning on July 22 to the village St. Paul Island. Received on board naval radio working party for transportation to Unalaska and a passenger for transportation to St. George Island. At 1.05 p. m. July 22 got under way and at 4.40 p. m. stopped off St. George Island. Landed passenger, then proceeded to Unalaska, arriving there at 4.15 p. m. July 23. * * *

At 10 a. m. September 28 the *Unalga* left Unalaska for Nome, via the Pribilof Islands, with mail and freight for the Bureau of Fisheries, Pribilof Islands. At 9.45 a. m. September 30 anchored in Garden Cove, St. George Island, and delivered mail and part of the freight. At 11 a. m. got under way and stood for St. Paul. At 5.10 p. m. anchored off East Landing, St. Paul Island. Delivered mail and received freight and mail to be transported to the American steamship *Victoria* at Nome; also received freight for transportation to Seattle for the Bureau of Fisheries. At 9.50 a. m. October 1 got under way and stood for Nome, arriving there at 10 p. m. October 3. * * * On October 15, at 6.45 p. m., left Nome for Unalaska, via the Pribilof Islands. Arrived at East Landing, St. Paul Island, at 10.25 a. m. October 19. Received on board Supt. A. H. Proctor, Mrs.' Proctor, and 23 of the employees of the Bureau of Fisheries with their freight and effects, together with mail, for Unalaska and St.

George Island. At 12.40 p. m. October 19 set sail from St. Paul Island. About an hour after sailing it was necessary to return, at the request of the superintendent of the Bureau of Fisheries, in order that he might look after some business that he inadvertently overlooked. At 5 p. m. October 19 anchored off St. George Island. Delivered freight for that place and received a passenger, mail, and freight for the Bureau of Fisheries. At 9.55 a. m. October 20, the weather having improved, got under way and stood again for St. Paul Island. * * * Unable to land, however, owing to violent gale. By midnight of October 22, the weather having moderated, made another attempt to reach St. Paul Island. The weather again becoming thick and stormy and as coal supply was running short it was necessary to stand for Unalaska. * * * Arrived at Unalaska at 3 p. m. same day. * * * At 7.30 a. m. November 17 the *Unalga* stood out through Akutan Pass. * * * Arrived Seattle at 7.35 p. m. December 8, where all passengers left the vessel.

Bear.—* * * At 1 p. m. September 13 the *Bear* anchored in Village Cove, St. Paul Island. Took on board 152 barrels of skins, some oil, and samples of seal meat. At 10.55 p. m. got under way for St. George Island, where arrived at 7.30 a. m. September 14. Received on board 32 barrels of sealskins for transportation to Seattle, 4 crates of foxes, and 1 box for transportation to Unalaska. At 12.55 p. m. got under way, and at 7.05 p. m. September 16 arrived at Unalaska. On September 24 got under way for Seattle, via Akutan Pass. On the morning of October 4 passed into the straits of Juan de Fuca, and at 7.15 p. m. same day made fast to wharf at Seattle, Wash. * * *

SEALING PRIVILEGES ACCORDED ABORIGINES.

A total of 766 fur-seal skins were taken by Indians off the coast of Washington and of southeastern Alaska in May and June, 1921. Of these 567 were taken by the Indians of Washington and were authenticated by A. D. Dodge, superintendent of the United States Indian School at Neah Bay, Wash. The remaining 199 were taken by the Indians residing in the vicinity of Sitka, Alaska, and were authenticated by G. G. Naud, master of the bureau's patrol boat *Murre.* Of the total taken 303 were from male seals and 462 from females, the sex of one not being stated. A patrol of the sealing grounds in the vicinity of Sitka, Alaska, was maintained by the bureau's vessels *Murre* and *Auklet* during the latter part of May while the seal herd was migrating. The presence of firearms in native canoes or open boats on the sealing grounds is regarded as prima facie evidence of violation of sections 3 and 7 of the act of August 24, 1912.

JAPANESE SEALSKINS DELIVERED TO THE UNITED STATES.

The 111 sealskins delivered to the United States in 1920 as this Government's share of skins taken on Robben Island in the years 1918 and 1919 were sold at public auction by the Fouke Fur Co. on February 21, 1921. The gross price bid was $3,434. After all deductions were made for expenses and commission the net proceeds of $2,912 were turned into the United States Treasury. The 56 skins which were this Government's share of the skins taken on Robben Island in 1920 were received at St. Louis on April 26, 1921. They had not been sold at the end of the year.

FUR-SEAL CENSUS, PRIBILOF ISLANDS, 1921.

By Edward C. Johnston.

In taking the census of the fur-seal herd on the Pribilof Islands in 1921 it was necessary for the writer to make two trips to St. Paul Island. It was intended to spend a few days on St. Paul Island in a preliminary examination of the rookeries, but adverse weather conditions prevented arrival there until the evening of July 14. The bull count began on July 16. Thanks are due to the commanding officers of the Coast Guard cutter *Unalga,* the U. S. S. *Saturn,* and the Bureau of Fisheries vessel *Eider* for their courtesies in providing transportation at the proper times.

The superintendent of the Pribilof Islands, A. H. Proctor, and the agent and caretaker of St. Paul Island provided necessary assistance in census work and also in erecting tripods before the arrival of the seal herd in the spring. Henry Mygatt, assistant to the agent of St. Paul Island, and J. M. Orchard, school-teacher, rendered valuable assistance at various times.

Conditions on the islands made it possible to spend but 13 days in all upon St. Paul Island. The rookeries could not be visited more than twice—once for the bull count and once for the pup count. Consequently field observations and preliminary counts of seals were not made on St. Paul Island as they were on St. George Island

TRIPODS AND MARKERS.

In the spring of 1921, before a great number of bulls had arrived, two tripods or counting towers were erected on Reef rookery, St. Paul Island. The tripods were 24 feet in height, made by joining three uprights at the apex and properly bracing them. Runways 1 foot wide and 6 feet above the ground extended back beyond the harem areas. The tripods were placed at the crest of the beach line, so that all parts of the harem area in the immediate vicinity were visible. The seals were not disturbed in the least by the presence of the tripods. In fact, the piles of rock at the bases of the tripods were playgrounds for large numbers of pups. A harem was located between the legs of one tripod.

An increase in the height and width of all runways should be made on sections extending over any harems; that is, the sections adjoining the tripods. The height should be 9 feet and the width 2 feet. An old harem bull can reach nearly 6 feet without effort. A handrail or rope along the high section of the runways would be a convenience but not a necessity.

There is no doubt that these two tripods made the harem count much more accurate in the areas visible from them. The erection of similar counting towers at points on other rookeries at the earliest possible date is strongly recommended. It would eliminate the necessity of counting from a boat, a method very uncertain on account

FIG. 20.—HERD OF REINDEER, ST. PAUL ISLAND.

FIG. 21.—TRIPOD AND RUNWAY TO ENABLE COUNTING OF SEALS, REEF ROOKERY, ST. PAUL ISLAND.

of the prevalence of rough weather. A sufficient number of tripods with markers separating the areas to be counted from each would make the harem count very nearly, if not entirely, correct. Tripods would not be necessary where natural elevations occur from which the whole harem area can be plainly seen.

Several concrete markers were made on St. Paul Island, but it was impossible to place them for use this year. They are similar to a concrete fence post in shape, 1 foot in diameter at the base and 6 inches at the top, with an iron rod protruding. Markers should be placed in lines dividing the areas to be counted from separate tripods or natural elevations.

DATES OF COUNTS.

The count of bulls was made at the height of the season, July 16 to 23, inclusive. The pup count was made this year several days earlier than has been the practice. To be as accurate as possible, the pup count must be made after all are born and before they begin to enter the water. This period is short. Observations on St. George Island rookeries showed that pups could be counted there on July 30. A close watch of the herd, together with the breaking up of the harems and the scattering of the pups, led to the conclusion that few, if any, pups would be born after that date. At the time the count was completed, August 7 on St. Paul Island, it was seen that if it had been delayed a few days many pups would have been in the water where they could not have been counted. On August 7 over 100 pups were in the water at Little Zapadni rookery. On August 6, when Morjovi rookery was counted, a few pups were in the water, but as the water was not of a sufficient depth to cover their bodies, none were overlooked in the count.

PUPS.

Pups were counted upon the same rookeries that were selected in 1920. With the average harem obtained on these rookeries, together with field observations, the number of pups upon each of the other rookeries has been computed. This method is very unsatisfactory in many ways, but it is the best that can be devised under the circumstances.

The importance of the pup count and the necessity for making it as accurate as possible are recognized from the fact that the average harem and number of breeding cows is derived directly from such figures. The increasing size of the herd has caused the count to be made on those smaller rookeries which were believed to represent conditions as applying to the herd as a whole. It is known though that the topography of the rookery plays some part in determining the size of the average harem. Field observations have been used in connection with the average harem of the rookeries where pups were counted in computing the average harem of other rookeries. At least one more complete pup count should be made before the herd becomes too large to make such a count prohibitive on several of the larger rookeries. It would bring to light any errors in computation that may have been made in the last few years and would furnish an accurate basis for computations in the future.

Distribution of pups on Pribilof Islands in 1921 and comparison with distribution in 1920.

Rookery.	1921					1920: Total pups.	1921	
	Date of count.	Living pups.	Dead pups.	Total pups.	Per cent dead pups.		Numerical increase.	Per cent increase (+) or decrease (−).
ST. PAUL ISLAND.								
Kitovi		4,300	53	[1] 4,353	1.22	3,764	589	+15.65
Lukanin		2,859	79	[1] 2,938	2.69	2,932	6	+.20
Gorbatch		10,610	299	[1] 10,909	2.74	10,251	658	+6.42
Ardiguen		1,072	16	[1] 1,088	1.44	1,180	−92	−7.79
Reef		24,022	616	[1] 24,638	2.50	23,638	1,000	+4.23
Sivutch		8,755	99	[1] 8,854	1.12	8,375	479	+5.72
Lagoon	Aug. 5	286	1	287	.35	341	−54	−15.84
Tolstoi		15,356	352	[1] 15,708	2.24	17,286	−1,578	−9.13
Zapadni		16,453	377	[1] 16,830	2.24	16,299	431	+2.63
Little Zapadni		9,812	225	[1] 10,037	2.24	12,494	−2,457	−19.67
Zapadni Reef	Aug. 5	486	16	502	3.19	532	−30	−5.64
Polovina	Aug. 7	5,912	159	6,071	2.62	6,006	65	+1.08
Polovina Cliffs	...do...	2,717	68	2,785	2.44	2,573	212	+8.24
Little Polovina		1,655	21	[1] 1,676	1.23	1,711	−35	−2.05
Morjovi	Aug. 6	2,942	52	2,994	1.74	2,936	58	+1.98
Vostochni		38,788	1,407	[1] 40,195	3.50	32,857	7,338	+22.33
Total		146,025	3,840	149,865	2.55	143,275	6,590	+4.60
ST. GEORGE ISLAND.								
North		9,787	199	[1] 9,986	1.99	9,126	860	+9.42
Staraya Artil		6,439	181	[1] 6,620	2.74	5,944	676	+11.37
Zapadni	July 30	884	11	895	1.23	907	−12	−1.32
South	...do...	184	3	187	1.60	99	88	+88.89
East Reef	Aug. 1	2,594	34	2,628	1.29	2,571	57	+2.22
East Cliffs		6,345	129	[1] 6,474	2.00	5,605	869	+15.50
Total		26,233	557	26,790	2.08	24,252	2,538	+10.47
Total (both islands)		172,258	4,397	176,655	2.48	167,527	9,128	+5.45

[1] Based on estimated average harem.

The percentage of dead pups is practically the same as it was in 1920. A decrease of 0.04 per cent for both islands is shown. This was to be expected, since there was no change in the conditions governing the percentage of dead pups that would materially increase or decrease the number.

The great variation of increase or decrease in the number of pups born on the various rookeries is remarkable. On St. Paul Island Vostochni rookery shows an increase of 22.33 per cent, while Little Zapadni rookery shows a decrease of 19.67 per cent. On St. George Island South rookery shows an increase of 88.89 per cent. It can not be said that the methods of computation are responsible for this variation, because the rookeries where pups were actually counted show the greatest variation. South rookery increased 88.89 per cent, while Lagoon rookery decreased 15.84 per cent. Neither of these rookeries has a hauling ground, and each was practically undisturbed during the breeding season.

COWS.

The number of breeding cows is the same as the number of pups, since a cow gives birth to a single pup annually and since barren cows, if there are any, do not affect the size of the herd. While counting the pups 11 dead cows were found. With 16,349 live cows on these

same rookeries the proportion of dead is 0.000673. Applied to the whole herd the number of dead cows would be 119.

No branded cows were seen on the St. Paul rookeries. During the limited time for observations there branded cows may have been overlooked. On St. George Island one cow bearing the 1902 brand (bar across the back) was seen on East Cliffs rookery, one on North rookery, and one on Staraya Artil rookery. Each of these three had large, healthy pups and showed no signs of senility. It is evident that cows may bear pups for 16 years at least.

BULLS.

HAREM AND IDLE BULLS.

The count of harem and idle bulls was made at the height of the season. The accuracy of the count of harem bulls is of the greatest importance, as it is from figures thus obtained that the average harem is determined for the rookeries where the pups are not counted. The error in this count increases in further computations and materially affects the total figures.

Two tripods were erected on Reef rookery this season as an experiment and proved to be invaluable in increasing the accuracy of the count. The erection of other tripods and the placing of markers has been taken up in another paragraph (p. 78). To secure an accurate count, it is absolutely necessary to reach an elevation from which all seals in a certain area can be seen. Counting from a boat is of some advantage, but many times the condition of the sea prevents the use of such a method. Also, just as the beach line can not always be seen from the rear of the rookery, the rear of the rookery can not always be seen from a boat.

Two bulls bearing the 1912 brand (T on top of head) were killed on St. George Island. At least three other branded bulls were seen on the rookeries. One badly crippled and wounded was seen among the harems on Staraya Artil rookery.

Harem and idle bulls and percentage of idle to harem bulls compared to average harem, Pribilof Islands, 1921.

Rookery.	Date.	Harem bulls.	Idle bulls.	Total bulls.	Per cent idle to harem bulls.	Average harem.
ST. PAUL ISLAND.						
Kitovi	July 16	161	32	193	19.88	27.04
Lukanin	...do....	100	23	123	23.00	29.38
Gorbatch	...do....	232	22	254	9.48	47.02
Ardiguen	...do....	32	2	34	6.25	34.00
Reef	...do....	521	66	587	12.67	47.29
Sivutch	(1)	190	60	250	31.58	46.60
Lagoon	July 20	16	....	16	....	17.94
Tolstoi	...do....	328	58	386	17.68	47.89
Zapadni	July 19	380	46	426	12.11	44.29
Suthetunga	...do....	....	....	....	....	....
Little Zapadni	...do....	213	50	263	23.47	47.59
Zapadni Reef	...do....	23	6	29	26.09	21.83
Polovina	July 17	161	46	207	28.57	37.71
Polovina Cliffs	...do....	111	22	133	19.82	25.09
Little Polovina	...do....	48	24	72	50.00	34.92
Morjovi	July 18	104	65	169	62.50	28.79
Vostochni	...do....	823	189	1,012	22.96	48.84
Total	....	3,443	711	4,154	20.65	43.53

[1] Count of 1920.

Harem and idle bulls and percentage of idle to harem bulls compared to average harem, Pribilof Islands, 1921—Continued.

Rookery.	Date.	Harem bulls.	Idle bulls.	Total bulls.	Per cent idle to harem bulls.	Average harem.
ST. GEORGE ISLAND.						
North	July 22	175	6	181	3.43	57.06
Staraya Artil	July 23	103	9	112	8.74	64.27
Zapadni	...do....	21	1	22	4.76	42.62
South	...do....	6	2	8	33.33	31.17
East Reef	July 22	53	13	66	24.53	49.58
East Cliffs	...do....	108	5	113	4.63	59.94
Total		466	36	502	7.73	57.49
Total (both islands)		3,909	747	4,656	19.11	45.19

The above table shows a decrease of number of harem bulls, a greater decrease of the number of idle bulls, and an increase in the average harem. The average harem for the entire herd is 45.19, which is as near the ideal size as can be expected. The idle bulls have decreased in number, until the percentage of idle to harem bulls is lower than it has been since 1914. The idle bulls not only form a reserve from which harem bulls are drawn, but they also are important as the class which serves most of the virgin cows. It is advisable to maintain this class at a certain proportion to the harem bulls for the latter reason. Normally there are about one-fifth as many virgin cows as there are breeding cows. The most desirable proportion is one idle bull to four or five harem bulls.[5] The failure of this class to appear in larger numbers points to the possibility that the males suffer a greater loss of life at sea than do the females.

AVERAGE HAREM.

Average harem in 1921 for all fur-seal rookeries on Pribilof Islands.

Rookery.	Breeding cows.	Harem bulls.	Average harem, 1921.	Average harem, 1920.
ST PAUL ISLAND				
Kitovi	4,353	161	[1] 27.04	[1] 28.52
Lukanin	2,938	100	[1] 29.38	[1] 30.86
Gorbatch	10,909	232	[1] 47.02	[1] 40.52
Ardiguen	1,088	32	[1] 34.00	[1] 29.50
Reef	24,638	521	[1] 47.29	[1] 44.77
Sivutch	8,854	190	[1] 46.60	[1] 44.08
Lagoon	287	16	[2] 17.94	[2] 24.36
Tolstoi	15,708	328	[1] 47.89	[1] 42.37
Zapadni	16,830	380	[1] 44.29	[1] 38.77
Little Zapadni	10,037	213	[1] 47.12	[1] 42.07
Zapadni Reef	502	23	[2] 21.83	[2] 19.00
Polovina	6,071	161	[2] 37.71	[2] 33.93
Polovina Cliffs	2,785	111	[2] 25.09	[2] 29.92
Little Polovina	1,676	48	[1] 34.92	[1] 34.92
Morjovi	2,994	104	[2] 28.79	[2] 30.27
Vostochni	40,195	823	[1] 48.84	[1] 45.32
Total	149,865	3,443	43.53	40.45
Total for rookeries counted	12,639	415	30.46	30.82

[1] Estimate. [2] Pups counted.

[5] Osgood, Wilfred H.; Edward A. Preble; and George H. Parker: The Fur Seals and Other Life of the Pribilof Islands, Alaska, in 1914. Bulletin, U. S. Bureau of Fisheries, Vol. XXXIV, 1914, p. 55. Washington, 1915.

Average harem in 1921 for all fur-seal rookeries on Pribilof Islands—Continued.

Rookery.	Breeding cows.	Harem bulls.	Average harem, 1921.	Average harem, 1920.
ST. GEORGE ISLAND.				
North	9,986	175	[1] 57.06	[1] 45.86
Staraya Artil	6,620	103	[1] 64.27	[1] 53.07
Zapadni	895	21	[2] 42.62	[2] 33.59
South	187	6	[2] 31.17	[2] 24.75
East Reef	2,628	53	[2] 49.58	[2] 38.37
East Cliffs	6,474	108	[1] 59.94	[1] 48.74
Total	26,790	466	57.49	46.28
Total for rookeries counted	3,710	80	46.38	36.50
Total (both islands)	176,655	3,909	45.19	41.20

[1] Estimate. [2] Pups counted.

The average harem for the entire herd is 45.19. East Cliffs rookery on St. George Island contained the largest average, with the exception of Staraya Artil rookery, there being but 1 bull to every 60 cows. Lagoon rookery on St. Paul Island had 1 bull to every 18 cows. These extremes show how the topography of the rookery influences the average harem. East Cliffs rookery is a narrow beach at the base of a high steep cliff. One end is closed by a vertical wall of rock at the water's edge. Expansion can only occur at the other end of the rookery and there is room for idle bulls only at that place. Lagoon rookery, on the other hand, has opportunity to expand in all directions, and it is easy for the idle bulls to capture a few cows. The bulls and harems can scatter all they please.

LOSSES OF MALES.

In the winter migrations of seals it has long been known that the adult males remain farthest north. The young males go farther south, and the females are found at the southern limits of migration. The killer whale, probably the greatest known enemy of the seal, is found around the Pribilof Islands, appearing in the spring at about the same time as the seals do. Although there is no definite evidence to support the supposition, it would not be impossible for these killers to follow the seals south as far as the males go and prey principally upon the younger males.

The increase of 3-year-old seals has not kept pace with the increase of cows. Sealskins taken in 1911, all or nearly all 3-year-olds, numbered 12,002. In 1920 there were 18,831 skins taken from this class. This is an increase of 56.9 per cent. The estimated number of cows was placed at 75,000 in 1911, a number not far from correct. In 1920 there were 167,527 cows, an increase of 123.37 per cent.

The 1920 census places the loss of seals during the first three years at 35 per cent for the first year, 15 per cent for the second, and 10 per cent for the third. These figures are probably not far wrong for the females. As the evidence seems to indicate a higher loss for the males, the percentages for the first three years are provisionally placed at 40 per cent for the first, 17½ per cent for the second, and 12½ per cent for the third. The losses for the fourth and subsequent

years are left the same as given in the 1920 census. As the male grows older his defensive powers increase. These figures are used in compiling the data in this census.

COMPLETE CENSUS.

It is expected that in 1922 a more complete count of pup wills be made and also additional counting towers constructed in the most congested areas of harems. For these reasons the results of the 1922 census will be as nearly exact as it is possible to make them. The figures in this report, which are based on estimates, are therefore presented with the provision that they may be revised should sufficient reasons come to light next year for different methods of forming the estimates.

Details of census of fur seals, Pribilof Islands, as of August 10, 1921.

	St. Paul.	St. George.
Pups, counted and estimated	149,865	26,790
Breeding cows, 3 years and over, by inference	149,865	26,790
Harem bulls, counted	3,443	466
Idle bulls, counted	711	36
Yearlings, male and female, estimated:		
Females born in 1920	71,638	12,126
Natural mortality, 35 per cent	25,073	4,244
Yearling females, Aug. 10, 1921	46,565	7,882
Males born in 1920	71,637	12,126
Natural mortality, 40 per cent	28,654	4,850
Yearling males beginning 1921	42,983	7,276
Yearling males killed 1921	10	....
Yearling males Aug. 10, 1921	42,973	7,276
2-year-olds, male and female, estimated:		
Yearling females, Aug. 10, 1920	43,522	7,559
Natural mortality, 15 per cent	6,528	1,134
2-year-old females, Aug. 10, 1921	36,994	6,425
Yearling males, Aug. 10, 1920	43,515	7,559
Natural mortality, 17½ per cent	7,615	1,323
2-year-old males beginning 1921	35,900	6,236
2-year-old males killed 1921	222	21
2-year-old males, Aug. 10, 1921	35,678	6,215
3-year-old males, estimated:		
2-year-old males, Aug. 10, 1920	33,698	5,413
2-year-old males killed fall 1920	2	23
3-year-old males, estimated—Continued.		
2-year-old males end of 1920	33,696	5,387
Natural mortality, 12½ per cent	4,212	673
3-year-old males beginning 1921	29,484	4,714
3-year-old males killed in 1921	16,183	3,347
3-year-old males, Aug. 10, 1921	13,301	1,367
4-year-old males estimated:		
3-year-old males, Aug. 10, 1920	9,344	1,405
3-year-old males killed fall 1920	233	312
3-year-old males end of 1920	9,111	1,093
Natural mortality, 10 per cent	911	109
4-year-old males beginning 1921	8,200	984
4-year-old males killed 1921	1,795	609
4-year-old males, Aug. 10, 1921	6,405	375
5-year-old males, estimated:		
4-year-old males, Aug. 10, 1920	4,584	1,083
4-year-olds killed fall 1920	46	44
4-year-old males end of 1920	4,538	1,039
Natural mortality, 10 per cent	454	104
5-year-old males beginning 1921	4,084	935
5-year-old males killed 1921	243	47
5-year-old males, Aug. 10, 1921	3,841	888

Details of census of fur seals, Pribilof Islands, as of August 10, 1921—Continued.

	St. Paul.	St. George.
6-year-old males, estimated:		
5-year-old males, Aug. 10, 1920	4,882	125
5-year-old males killed fall 1920	2	3
5-year-old males end 1920	4,880	122
Natural mortality, 20 per cent	976	24
6-year-old males beginning 1921	3,904	98
6-year-old males killed 1921	9	2
6-year-old males, Aug. 10, 1921	3,895	96
Surplus bulls, 7 years and over, estimated:		
6-year-old males, Aug. 10, 1920	3,952	201
6-year-old males killed fall 1920	....	....
6-year-old males end of 1920	3,952	201
Natural mortality, 20 per cent	791	40
7-year-old males beginning 1921	3,161	161
Surplus bulls, Aug. 10, 1920	5,147	968
Surplus bulls killed fall 1920	1	0
Surplus bulls end of 1920	5,146	968
Natural mortality, 30 per cent	1,544	290
Surplus bulls, 7 years and over, estimated—Con.		
Remaining surplus for 1921	3,602	678
Breeding bulls of 1920	4,620	607
Natural mortality, 30 per cent	1,386	182
1920 bulls remaining 1921	3,234	425
Breeding bulls of 1921	4,154	502
1920 bulls remaining, deducted	3,234	425
Increment of new bulls 1921	920	77
7-year-old males computed for 1921	3,161	161
Surplus bulls computed for 1921	3,602	678
Total theoretical surplus bull stock for 1921	6,763	839
7-year-old males killed in 1921	2	2
Total surplus in 1921	6,761	837
New increment breeding bulls deducted	920	77
Surplus bulls 1921	5,841	760
50 per cent deducted for losses due to fighting, natural causes, and errors in loss percentage in previous years	2,920	380
Surplus bulls, Aug. 10, 1921	2,921	380

RECAPITULATION.

	St. Paul.	St. George.	Both islands.
Pups	149,865	26,790	176,655
Cows	149,865	26,790	176,655
Harem bulls	3,443	466	3,909
Idle bulls	711	36	747
Yearling females	46,565	7,882	54,447
Yearling males	42,973	7,276	50,249
2-year-old females	36,994	6,425	43,419
2-year-old males	35,678	6,215	41,893
3-year-old males	13,301	1,367	14,6[illegible]8
4-year-old males	6,405	375	6,780
5-year-old males	3,841	888	4,729
6-year-old males	3,895	96	3,991
Surplus bulls (7 years and over)	2,921	380	3,301
Total, 1921	496,457	84,986	581,443
Total, 1920	....	....	552,718
Numerical increase, 1921	....	....	28,725
Per cent increase, 1921	....	....	5.2

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THE KENTUCKY RIVER AND ITS MUSSEL RESOURCES.[1]

By Ernest Danglade, *Formerly Field Assistant, U. S. Bureau of Fisheries.*

CONTENTS.

KENTUCKY RIVER AND ITS THREE UPSTREAM FORKS.

The basin of the Kentucky River is situated in the eastern portion of Kentucky and embraces about one-sixth of the State, or approximately 6,700 square miles. The mountain sections, which are within the Cumberland Plateau, are rough and uneven, varying in elevation from 1,000 to 3,200 feet. The lower two-thirds of the basin descends gradually from 1,000 to about 450 feet. Omitting the small tributaries leading down from the mountains, the river has a fall of about 800 feet, an average of 2 feet per mile. The upper third of the stream has a fall of about 3½ feet per mile; the remainder of about 0.9 foot per mile.

The headwaters of the river, consisting of three branches, the North, Middle, and South Forks, have their sources along the northern slopes of Pine Mountains. The streams flow in a general northwesterly direction and unite near Beattyville to form the main stream which continues in the same direction and flows into the Ohio River at Carrollton. Including North Fork the river has a length of about 400 miles, but in a direct line from source to mouth the distance is about 175 miles. The difference of 225 miles is due to numerous windings and bends, including two large sweeps, one to the north and one to the south.

It is interesting to note that the Cumberland and Big Sandy Rivers have their origins on the slopes of Pine Mountains and that the headwaters of these streams are but a few hundred yards from those of the Kentucky.

The river holds the center of the basin from its source to below Valley View, a distance of about 240 miles, whence it bears decidedly westward, especially from High Bridge to the mouth. The width of the stream is from 75 to 250 feet and the depth from a few inches to 4 or 5 feet in the upper stretches during low water up to 40 or more feet in the lower river in times of flood. The banks are moderately low and are composed of mud, loam, or solid rock. The bottom lands, which are generally rather narrow, are fertile and

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[1] Appendix XI to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 934.

extensively cultivated. The bed of the stream in the upper divisions consists of a series of riffles or shoals having a solid or shingle rock floor and long reaches of sand foundation in the pool areas. Through the presence of 14 locks and dams, maintained by the Federal Government, the main stream or the lower two-thirds of the river is in pool stages and has, for the most part, a soft mud bottom.

The river basin contains five geological formations. The first, located in the southeastern portion, is the Subcarboniferous formation. It is represented by the Pine Mountains, which form a long, narrow band or elevation rising above adjacent sandstone areas, and is composed mostly of limestone, a mineral of first importance in the nutrition of the heavy-shelled fresh-water mussels. The next is the Carboniferous, with extensive deposits of an excellent quality of coal. The other formations, composed mainly of limestone, are in order as follows: the Devonian, the Silurian, and the Ordovician. Since the Subcarboniferous comes to the surface toward the north as well as in the mountains, it would appear that the Carboniferous occupies and fills a broad, deep, and extensive valley of limestone—the Pine Mountains on the southeast and the Blue Grass region on the northwest. The waters flowing through this region are rather hard, obtaining their soluble calcium compounds, which are essential to mussel growth, from these extensive deposits of limestone.

Besides the three principal forks, there are many small side streams and creeks flowing into the river. The largest of these are the Red River and Eagle Creek from the east and the Dix River from the south.

The water of the Kentucky is more or less turbid at all seasons of the year. During periods of heavy rainfall there is considerable crude oil wastage from the adjacent oil fields spreading over the river's surface. Other than this, however, there is not an undue amount of pollution contaminating the water and detrimental to aquatic life.

SHIPPING FACILITIES.

The following list gives the larger towns along the main river and along the three large upstream forks that have railroad connections:

MAIN KENTUCKY RIVER.

Carrollton	Carrollton & Worthville R. R.
Frankfort	Louisville & Nashville R. R. Frankfort & Cincinnati R. R. Chesapeake & Ohio R. R.
Tyrone	Southern R. R.
High Bridge	Do.
Valley View	Louisville & Nashville R. R.
Ford	Do.
Irvine	Do.
Beattyville	Do.

NORTH FORK OF KENTUCKY RIVER.

Jackson	Louisville & Nashville R. R. Ohio & Kentucky R. R.
Frozen	Ohio & Kentucky R. R.
Hazard	Louisville & Nashville R. R.

Louisville & Nashville Railroad parallels the stream from Jackson nearly to its source.

FIG. 1.—THE KENTUCKY RIVER AND ITS PRINCIPAL RAILROAD CONNECTIONS.

MIDDLE FORK OF KENTUCKY RIVER.

Louisville & Nashville Railroad parallels the stream from its mouth to Athol. No railroad connections farther up stream.

SOUTH FORK OF KENTUCKY RIVER.

No railroad connections on this stream. Nearest railroad shipping point is at Beattyville, at the mouth of the Fork.

The railroad shipping facilities are poor for the immediate and direct handling of fishery products except on the North Fork and on the main stream from Beattyville to below Irvine, where the Louisville & Nashville Railroad parallels the channel. The railroad shipping points other than here are located at points from 30 to 50 miles apart and, for their use in shipping, fresh-water mussels would require previous shipment by packet or towboat. Transportation is further facilitated, however, by the 14 Government locks and dams previously mentioned. These agencies to improve river commerce have made the lower 255 miles of the river from Beattyville to Carrollton navigable for steamboats and other craft at all seasons of the year, except during times of heavy ice. Thus by towing or shipping by small boat or packet the railroad points may be quite readily reached.

MUSSEL BEDS.

There are many mussel beds in the upper Kentucky, and, although small in extent when compared with those of the Ohio and Mississippi Rivers, they are generally well stocked and good yielders of commercial shells. The greater portion of the bars occupied by mussels range in area from small patches of a few square yards to 2 or 3 acres or more.

The beds may not be situated in the bends, as is often the case in the Ohio River, but in localities having permanent or but slightly shifting bottoms, in which mussels can burrow and maintain a foothold. The greater number of such grounds, as the riffles or shoals, are found off creeks and small streams or in favorable sections alongshore, usually immediately above the shoals and opposite the channel. The riffles and other mussel-bearing districts are fairly regular in distribution, averaging about two per mile in the most favorable sections. There are four principal classes of shell beds in the headwaters.

(1) The riffles. When occurring on a bar of this class, the mussels are distributed practically all over it, excepting perhaps in the swifter parts and channel. In some places they are found living for some distance below as well as above the main riffles.

(2) Areas situated above exposed bars and in the shallower chutes, but seldom in the channel.

(3) Favorable bottoms at the lower end of long pools or at the beginning of shoals, where the current is slow, but uniform throughout. Also directly above and below fords.

(4) Sections alongshore; occasionally a portion of a bar extending across the river. On these beds there are usually large bowlders and a shingle or sand-mud bottom. These grounds are generally some distance from the shoals.

There are also small bars and patches here and there on good bottoms and scattering mussels between large adjacent beds where the current is moderate and the bottom is somewhat unstable or else too hard for safe burrowing. Wherever a favorable bottom of any size occurs in the streams mussels are to be found. A good indication of a shell bed, particularly alongshore, is a growth of water willows in moderate current.

The most productive mussel area in North Fork is the stretch from Hazard, Perry County, to Log Shoals, Lee County, a distance of about 75 miles. The following list of beds in North Fork were worked to some extent during the shelling seasons of 1919 and 1920:

Doughty Shoals, 2½ miles above Haddix, Breathitt County.
Jackson or Coal Chute Bed, Jackson.
War Shoals, 3 miles below Ohio & Kentucky Railroad Junction.
Si Bend, 2 miles above Frozen.
Frozen Bed, Frozen.
Cedar Point Shoals, 3 miles below Frozen.
War Creek Shoals, near county line between Breathitt and Lee Counties.
Hieronymus Ford, Lee and Wolfe Counties.
Hays Bar, Lee County.
Upper Twin Shoals, 10 miles above Beattyville.
Tea Table Shoals, off Tea Table Branch, Lee County.
Aggie Riffle, near Primrose.
Laurel Shoals, off Laurel Branch, Lee County.
Log Shoals, off Log Branch and at the head of slack water.

Only limited shelling has been carried on in Middle Fork. The best beds in this stream are as follows:

Mill Creek Shoals and vicinity, near Tallega, Lee County.
Section between Monica, Lee County, and Athol, Breathitt County.

There are doubtless some good beds above these stretches, but the stream becomes rather small and transportation facilities are unsatisfactory for heavy loads.

No shelling has been done in South Fork. There are small beds in the section of the stream between the head of slack water and Booneville, Owsley County, thence to Bronner Bend, about 5 miles by water above Booneville, and at points above. There are no railroad or steamboat shipping facilities on this fork, and during periods of low stage of water it is impossible to tow heavy loads in small flatboats or barges. This would necessitate hauling overland over rough roads.

As an indication of the productiveness of the upper reaches of the Kentucky River it should be mentioned that during the shelling operations of 1919 two carloads of marketable shells were gathered from the beds of North and Middle Forks and sold at a good price. So far as was determined by an inspection of the grounds, the beds were not injured by the season's industry. In 1920 the stretch from above Haddix to Log Shoals, a distance of about 35 miles, gave a return of 87 tons of desirable shells. Rain, high water, and a general shortage of help prevented a greater yield.

It is not to be understood that the output of these streams will equal that of such rivers as the Cumberland, Wabash, or Illinois, or that the supply will be inexhaustible. It is evident, however, that if fished within reason and at the proper seasons, they will yield an appreciable regular annual return. With continued heavy and undue shelling, they are liable to reach depletion within two or three years.

FIG. 2.—NORTH FORK OF KENTUCKY RIVER, 2 MILES ABOVE LOTHAIR.

The bottom is rocky, with some sand and gravel. Only scattering mussels were found.

FIG. 3.—NORTH FORK OF KENTUCKY RIVER, DOUGHTY SHOALS.

A fine mussel bed here, mostly muckets. The best portion of the bed is along the opposite shore where the water is rather deep and has little current. The white streak is water flowing over the riffles.

FIG. 4.—NORTH FORK OF KENTUCKY RIVER, DOUGHTY SHOALS.

This shows the riffles and the pool above. The riffles are situated diagonally across the river.

FIG. 5.—SOUTH FORK OF KENTUCKY RIVER, NEAR BRONNER BEND SHOALS.

Some mussels are found here. Bottom rocky, with sand and gravel.

FIG. 6.—SOUTH FORK OF KENTUCKY RIVER, BRONNER BEND SHOALS.

This shows the left chute around a small bar covered with water willows. Mussels, including the Truncillas, are found here.

FIG. 7.—SOUTH FORK OF KENTUCKY RIVER, BRONNER BEND SHOALS.

This shows the right chute around a small bar covered with water willows. Mussels are found here.

MUSSELS.

The mussels of the Kentucky River are neither uniformly nor indiscriminately distributed over a given mussel-bearing area but are found more or less grouped in the sections having standard bottom conditions. They occur, as a rule, more frequently at those places with a penetrable bottom in the quieter waters and near shore than in the swift portions and in the channel. The mussels are often found densely crowded in the beds, standing on end, but so arranged, if possible, that the tips of the shells point upstream.

The 40 species of mussels found in the Kentucky River and herewith listed probably do not represent the number occurring in the drainage or even in the headwaters. Of the 40 listed species 22 are of commercial value in button manufacture. The following table gives the names and comparative occurrence of mussels, weight of shells, and other considerations of value to the mussel fisherman and the manufacturer.

Mussels of the Kentucky River and its upstream forks.

Common name.	Scientific name.	Value as button material.	Number of shells per ton.	Occurrence.
Elk-toe	Alasmidonta marginata	None		Occasional.
	Alasmidonta minor [1]	do		Rare.
Floater	Anodonta grandis	do		Occasional.
Paper-shell	Anodonta imbecillis	do		Rare.
Fan-shell	Cyprogenia irrorata	Fair		Do.
Pink heel-splitter	Lampsilis alata	None		Common.
Yellow sand-shell	Lampsilis anodontoides	Very good		Rare.
Slough sand-shell	Lampsilis fallaciosa	None		Occasional.
Paper-shell	Lampsilis gracilis	do		Do.
Mucket	Lampsilis ligamentina	Very good	3,200-7,100	Very common.
Fat mucket	Lampsilis luteola	Good		Occasional.
	Lampsilis multiradiata [1]	Poor		Do.
	Lampsilis parva [1]	None		Rare.
Black sand-shell	Lampsilis recta	Fair		Common.
Pocketbook	Lampsilis ventricosa	Good	3,200-5,300	Do.
Three-horned warty-back.	Obliquaria reflexa	Fair		Rare.
Round shell	Obovaria lens	Poor		Occasional.
	Plagiola donaciformis [1]	None		Do.
Deer-toe	Plagiola elegans	Poor		Common.
Club-shell	Pleurobema clava	None		Rare.
Kidney-shell	Ptychobranchus phaseolus	do		Do.
Flat niggerhead	Quadrula coccinea	do		Occasional.
Rabbit's foot	Quadrula cylindrica	do		Rare.
Purple warty-back	Quadrula granifera	do		Occasional.
Washboard	Quadrula heros	Fair		Do.
Long niggerhead	Quadrula kirtlandiana	Good	6,400	Common.
Maple-leaf	Quadrula lachrymosa	do	4,000	Occasional.
Pimple-back	Quadrula pustulata	do		Do.
Do	Quadrula pustulosa	do	4,200-7,100	Common.
Wabash pig-toe	Quadrula rubiginosa	Fair		Do.
	Quadrula solida [1]	None		Occasional.
Long niggerhead	Quadrula subrotunda	Good		Common.
Three-ridge	Quadrula undulata	Fair	3,700-6,400	Do.
Squaw-foot	Strophitus edentulus	None		Do.
White heel-splitter	Symphynota complanata	Fair		Do.
Fluted shell	Symphynota costata	None		Abundant.
Pistol-grip	Tritogonia tuberculata	Good		Common.
	Truncilla rangiana [1]	Poor		Rare.
Snuffbox	Truncilla triquetra	do		Do.
Lady-finger	Unio gibbosus	None		Common.

[1] There is no common name in use for this species.

The mucket, *Lampsilis ligamentina*, is the most valuable commercial shell and the predominating species of the headwaters of the Kentucky River. The shell beds, as a rule, average from 90 to 95 per cent of this shell. The following instances are cited to show the

abundance and crowded condition of the mussels in many localities. On a bed in North Fork, Hays Bar, Lee County, a fisherman, standing in water about 2 feet deep, gathered from one spot, without moving his feet, 50 muckets and one lady-finger. A yard further out in the river and under similar conditions he took 81 mussels, enumerated as follows: 77 muckets, 1 pistol-grip, 1 lady-finger, 1 pink heel-splitter, and 1 fluted shell. In the same stream at Doughty Shoals, Breathitt County, a sheller gathered from a spot of sand bottom formed below a large rock 170 mussels, mostly mature muckets. On this latter bed, which had been worked during the season of 1920, there were observed on an area of 1 square foot the extreme tips of 11 large, deeply burrowed muckets.

The nacre of the muckets is usually clear white with very rare brownish stains in the region of the umbone. The shell texture is firm, in some mussels quite hard, with a tendency to be brittle. The mussels are, however, of good quality, though perhaps not equal to that of the same species of more northern streams. The medium and smaller sized shells of this mucket are tolerably uniform in thickness and furnish the best button material. This uniformity of thickness makes it possible to cut excellent tips from the shells. The older shells are much thicker anteriorly and correspondingly heavier.

The mucket appears to be holding its own in the Kentucky River, as a great many of the mussels found were gravid. A large number of juveniles of this species were also encountered, and it appears that natural reproduction of this species is occurring in large amount. The shells of commercial size, number per ton, are as follows: Large size, 3,200; medium, 4,200; and small, 7,100.

The washboard shells are for the most part very large and very heavy shells, with good white nacre and very few stains. The black sand-shells are white nacred and of a weight and texture desirable for button manufacture.

The mussel fauna of the Kentucky, as determined principally by the species found in the headwaters and creeks, is practically that of the Ohio. This is especially indicated in the headwaters by the great frequency of the mucket shell. This fact is emphasized also by the occurrence on the upstream beds of the following species: *Truncilla rangiana*, *Obovaria lens*, *Quadrula rubiginosa*, and *Lampsilis luteola*. The only species indicating a faunal connection with the Cumberland drainage is *Alasmidonta minor*, which was taken near the extreme upper limits of the river, not far from the source of the Cumberland. The following mussels, common on many shell beds of the Ohio and more or less large river forms, were not observed in the Kentucky: Niggerhead, *Quadrula ebenus;* Ohio River pig-toe, *Q. obliqua;* elephant's ear, *Unio crassidens;* Missouri niggerhead, *Obovaria ellipsis;* and butterfly, *Plagiola securis*. The absence of these shells is perhaps due to their restricted parasitism of fishes that do not ascend the Kentucky River from the Ohio. This is particularly true of the river herring, the host of the niggerhead. It is not known to have been taken in the headwaters of the Kentucky drainage.

The principal fishes observed in the Kentucky River that are important in keeping the mussel beds stocked are the black bass, the sunfish, the drum, the channel and mud catfishes, gars, suckers, redhorse, and minnows.

PEARLS.

The upper stretches of the Kentucky River are not rich in pearl production. From the good quality of the nacre and the fine condition of the predominating mussel, the mucket, together with the general character of the streams, it would appear that the headwaters should yield many valuable gems and an abundance of good baroques. But such is not the case.

These streams, like so many other rivers of the Mississippi Basin, were doubtless visited long ago by the pioneers of the shell industry, the pearl hunters. The output of pearls then was probably so small and the good finds so rare that the hunters left for other fields in anticipation of more remunerative returns. They were interested only in pearls and, though the beds were full of fine mussels, the river was presumably pronounced of no value and was lost sight of for commercial shells.

Only two or three pearling expeditions were learned of and these relate to local pearl hunters working at odd times in some of the larger tributaries of North Fork. The best finds were evidently of only a moderate character. No signs of recent pearl hunting were seen. During the limited shelling seasons of 1919 and 1920 no particularly good finds were reported by those engaged in the mussel-fishing industry. What was found was of small quantity and mediocre quality. The baroques and slugs averaged as low as one-eighth ounce per ton of shells. During the busy shelling season it is hardly profitable for the shuckers to search diligently for slugs and valuable pieces while separating the meats from the shells.

METHODS OF MUSSEL FISHING.

Notwithstanding the fact that the mussel beds of the Kentucky are practically free from snags and serious hangups, the very hard and often uneven surfaces are not suited to such appliances as the crowfoot dredge, the dip net, tongs, or rake. The compactness of the bottom so firmly and securely embeds the mussels that these implements are quite useless to the sheller. The shell-fork, however, can be employed on some of the softer bottoms.

The method of giving the best results and the one generally pursued on the headwaters is that of wading and taking the mussels by hand. This method is, of course, dependent on low stages of the water. A sheller's john boat is usually taken along side; besides affording temporary holding equipment, it is used to deliver the catch to the camps. About the only other equipment necessary is a shell-fork and a bucket when collections are made at some distance from the boat. With the exception of the juvenile shells, the mussels are, as a rule, buried seven-eighths or more of their lengths in the hard bottoms and are removed with difficulty.

SUMMARY.

The Kentucky River is approximately 400 miles long and contains many valuable mussel beds. In the upper reaches of the stream these number about two per mile of channel. They have well defined and characteristic locations easily marked.

The upper Kentucky River is practically an unknown and unworked mussel-bearing stream and contains an abundance of mussels of commercial value, possessing good nacre and texture. Of these the mucket constitutes about 90 per cent. This shell has a desirable color, texture, and uniformity of thickness throughout. It appears probable, therefore, that this stream may be particularly useful in the near future as a source of remunerative employment for the mussel fisherman and of desirable raw material for the button manufacturer. The pearls of this river, as a by-product of mussel fishing, are of small consequence, both in the quantity and quality of the pieces found.

The railroad and steamboat shipping facilities of the main river, of North Fork, and of lower Middle Fork are satisfactory. On the upper Middle Fork and on South Fork there are no railroad or steamboat connections and shipments must be handled by small boats. In particularly dry seasons of the year transportation must be made by hauling over rough roads. This is especially true of the South Fork.

The method of shell fishery in the Kentucky River is limited principally to hand picking or to the use of the shell-fork. A stiff bottom in which the mussels bury themselves deeply makes implements commonly used elsewhere in shelling useless in this river.

Of 40 species of mussels observed as indigenous to the river, 22 are commercially usable, but only 9 are of relative importance. This number includes as the most common shells suitable for button manufacture the mucket, the pocketbook, the pimplebacks, the pistolgrip, the long niggerheads, the maple leaf, and the fat mucket.

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GOLDFISH: THEIR CARE IN SMALL AQUARIA.[1]

By E. C. Fearnow,

Superintendent of Fish Distribution, U. S. Bureau of Fisheries.

CONTENTS.

INTRODUCTION.

Although the Bureau of Fisheries neither propagates nor distributes ornamental fish, the need of a publication for use in answering the numerous inquiries concerning the care of goldfish has been apparent for some time. It is the aim of this article to set forth briefly such practical advice as appears necessary for the amateur aquarist.

Since the bureau is concerned in the propagation of the food and game fishes only it has no literature on the methods of goldfish breeding. Excellent advice on this subject may be obtained by consulting the current publications on goldfish. Neither does the bureau serve as a medium for advertising goldfish or aquarium accessories. Publications devoted to aquarium fishes and related subjects contain advertisements of dealers in goldfish, aquatic plants, and in fact everything that is needed by the aquarist.

In the preparation of this publication the following authorities have been freely consulted: Wolf, Mulertt, Innes, and Aquatic Life. (See Bibliography.)

SUITABLE FORM OF AQUARIUM.

Because of its narrow neck the so-called fish globe is not adapted to keeping goldfish in a comfortable and healthy state, its small amount of water surface not permitting the process of absorption of air on a scale sufficient for the well-being of the fish. Another objectionable feature of the globe lies in its reflection and refraction of light rays, which tends to make the fish nervous and uneasy.

An aquarium with straight sides is the only suitable form. It should be of rectangular shape and of equal width at the top and bottom. The rectangular battery jar, which may be purchased in the 5-gallon size, will give good results. The depth of water should be about the same as the width of the aquarium, and the bottom should be covered with clean sand and gravel to the depth of 1½ inches. Ordinary sand and pebbles are best for this purpose, as the more desirable aquarial plants draw most of their nourishment from the water and require merely an anchorage. In order to insure an abundant air supply, plants of high oxygenating powers should be selected for the aquarium.

[1] Appendix XII to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. 935.

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SUITABLE AQUARIAL PLANTS.

Among the most suitable plants for an aquarium are anacharis and fanwort. Anacharis, *Anacharis canadensis gigantea* (Fig. 1), is a good oxygenator and at the same time provides forage for goldfish. Fanwort, *Cabomba caroliniana* (Fig. 2), is a very hardy species and thrives well in small aquaria. It is evergreen, will grow from cuttings, especially the forked joints, and a branch planted in the sand at the bottom of an aquarium will produce roots. These plants are very common, and supplies can usually be purchased from goldfish dealers. Other desirable aquarial plants are willow moss, *Fontinalis antipyratica* (Fig. 3), and arrowhead, *Sagittaria natans* (Fig. 4). Very beautiful aquatic gardens may be made by a proper selection of plants. A frequently used and very hardy and beautiful plant is the hornwort, *Ceratophyllum demersum* (Fig. 5), but it requires careful attention, as it is liable to decay and contaminate the water. Moreover it is dormant in the winter and has only decorative value at that period. Ludwigia, *Ludwigia glandulosa* (Fig. 6), is highly prized for its fine appearance in the aquarium and is easily propagated from cuttings.

FIG. 1.—Anacharis (*Anacharis canadensis gigantea*). One-half natural size. A good oxygenator; grows rapidly; thrives with or without roots when set in pebbles or sand; may be purchased of dealers. This is considered the most satisfactory plant for the amateur aquarist.

BALANCED AQUARIUM.

When the relations of plant life and animal life in an aquarium are properly proportioned the aquarium is said to be self-sustaining or balanced, and under such a condition the water requires no change. Filling in to make up for what has evaporated is all that is necessary; or, if preferred, about half the water may be drawn off through a siphon and a similar amount of fresh, aerated water added. During very warm weather this will probably have to be done about once a month. If the water should become vitiated at any time the aquarium must be thoroughly cleansed and the entire water supply renewed, the fish first having been removed to another vessel. When fish become restless and rise to the surface of the water to breathe, it indicates that the oxygen supply in the aquarium is insufficient. Relief may be given them by dipping up and pouring back some of the water.

A small aquarium can not sustain much life. Fishes, like human beings, can not thrive in crowded habitations, and thousands of goldfish have been lost by the overstocking of aquaria. The number that can be maintained in healthful condition in a 5-gallon vessel

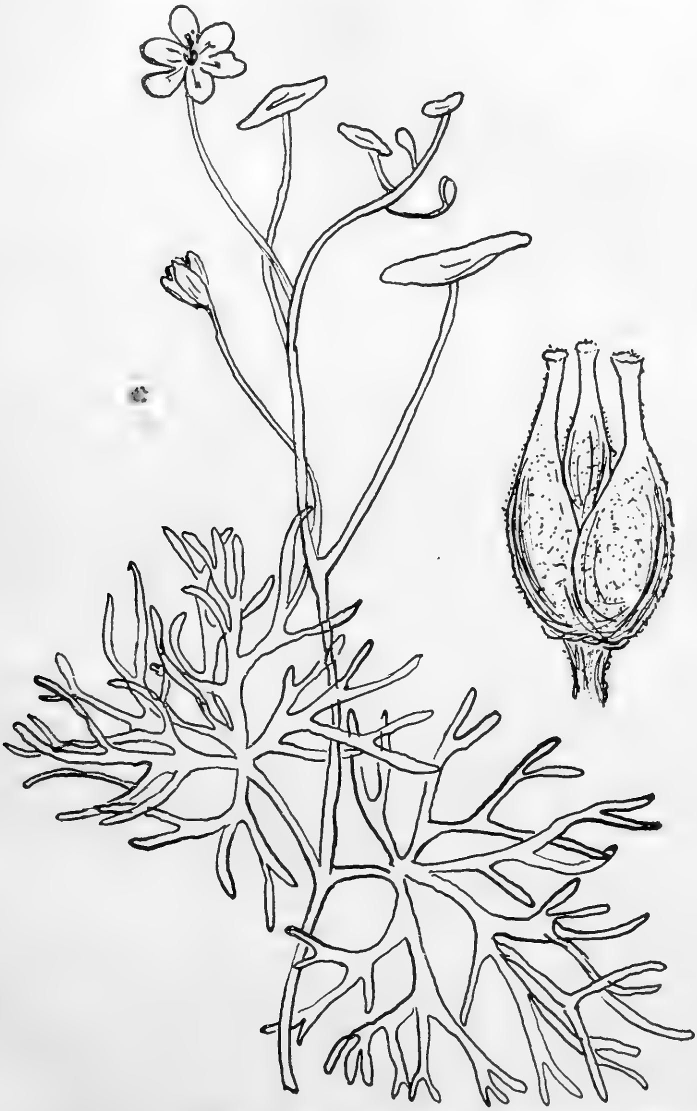

FIG. 2.—Fanwort (*Cabomba caroliniana*). Natural size. Found in ponds and slow streams, southern Illinois to North Carolina, south to Florida and Texas.

will depend upon its location and shape, the water temperature, character of the plant life, size of the fish, and the amount of light admitted.

It is better for beginners to start with a few of the hardier varieties of goldfish until the fundamental principles of aquarium keeping are

understood. When common goldfish can be kept with no losses it is time to branch out and undertake the keeping of the more interesting breeds.

A well-balanced aquarium of 5-gallon capacity is capable of maintaining two goldfish, each 2 inches long exclusive of tail, one frog tadpole, and four snails. One-fourth of the bottom area should be planted with aquatic vegetation, the ends or roots to be embedded from 1 to 1½ inches in the sand or gravel and the plants evenly distributed over the entire surface, to admit light and provide for the free movement of the fish. In choosing the snails select species that do not feed on plants. The best ones are the Planorbes and Vivipara. Snails help to keep down the growth of algæ, while the tadpole acts as a scavenger, consuming all waste matter in the aquarium. When about to enter the frog stage the tadpole must be provided with a resting place on the surface of the water, otherwise it will drown. In a 5-gallon aquarium two handsome specimens of fringetail goldfish will make a fine appearance. Once or twice a week the inside surface of the front glass should be cleaned, to prevent obstruction of the view by accumulations of algæ. For this purpose a flat sponge or piece of felt attached to the flattened end of a stick will be effective. Sediment may be removed by a glass dip tube or rubber siphon.

FIG. 3.—Willow moss (*Fontinalis antipyratica*). Natural size. A fairly good oxygenator.

A 5-gallon aquarium is the minimum size recommended, but when it is possible a larger vessel should be used. A tank 24 inches long, 12 inches wide, and 15 inches high, with a capacity of 18 gallons, makes a suitable aquarium for a parlor or living room. A receptacle of that size should maintain five 2-inch fish of different types and varieties, two tadpoles, and ten snails. When larger aquaria are used the number of fishes, scavengers, and plants may be increased proportionately. If the fish are larger their number should be correspondingly reduced. A good rule in stocking an aquarium is to allow 1 gallon of water to each one-half inch of fish.

LIGHT.

The aquarium should have a northern or northeastern exposure in summer, but in winter it is advisable to so locate it that it will get the sunlight two or three hours a day. The light should enter an

aquarium in about the same way it enters a stream, from the surface of the water. Too much light will overstimulate the growth of algæ, causing the water to turn green.

WATER.

The best water supply for an aquarium is nearly always from a river, pond, or cistern, as water from such a source conforms more nearly to natural conditions. Well water usually contains lime or salts, especially lime, making the water hard and entirely unsuited to the purpose.

TEMPERATURE.

The temperature of the water in an indoor aquarium will range from 50 to 80° F. in winter and from 65 to 80° F. in summer. A temperature somewhat in excess of 85° should not prove harmful if the water is well aerated, but if the fish show signs of distress their condition may be improved by reducing the number in the aquarium. In all cases avoid sudden changes in water temperature.

REPLACEMENT OF MINERALS.

Provision should be made to replace minerals that are constantly absorbed from the water by plants and fishes. This can be done by occasionally adding salts, a mixture of three parts of evaporated sea salt and one part of Epsom salts. A level teaspoonful to 20 gallons of water about once in two or three weeks is considered beneficial. The fishes will usually swallow these salts, which act as a mild cathartic.

FIG 4.—Floating arrowhead (*Sagittaria natans*). One-half natural size. A very desirable plant for the aquarium. Flowers above water surface, but fruit ripens on or below the surface of the water.

PREVENTION OF ACID CONDITION.

For the prevention of an acid condition in the aquarium, which is usually brought about by the decomposition of plants, a small piece of plaster of Paris in the aquarium is recommended. The plaster of Paris neutralizes the acid, and as it dissolves only under acid conditions there is no danger of getting the water too alkaline. When the plaster of Paris dissolves quickly it is a sure sign of acid condition.

FOOD.

Most aquarium fishes desire a variety of foods, and the aquarist should endeavor to imitate nature. Whatever foods are used it should always be borne in mind that a balance of vegetable, animal,

and mineral content is required. The best prepared foods are those that are granular in form and usually of dark color. Such foods may be purchased at pet stores and contain a mixture of flour, fish roe, meat, etc. Dried bread crumbs are frequently recommended as food for goldfish, especially when whole wheat bread is used.

Goldfish in an aquarium should be fed every day in summer and every other day in winter. Substitutes for natural food are scalded and dried earthworms, dried liver, fish roe, ant eggs, rice flour, pea flour, etc. Many combinations may be used, the best ones being

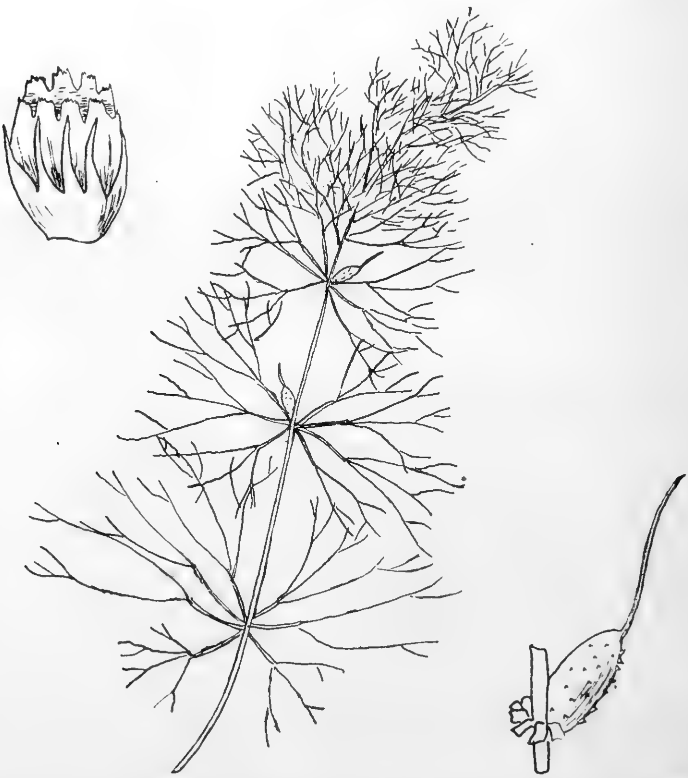

FIG. 5.—Hornwort (*Ceratophyllum demersum*). Natural size. Found in ponds and slow streams throughout North America, except extreme north. This plant is shallow-rooted, deriving most of its sustenance from the water.

those containing animal, crustacean, and starchy ingredients, together with some digestible form of lime, such as powdered egg shells, table salt, and Epsom salts.

A well-known goldfish food consists of 5 ounces of pea flour, 4 ounces of rice flour, 2 ounces of dried and powdered fish flesh (herring), $\frac{1}{2}$ ounce of finely divided dried meat fiber (beef heart), 2 ounces of dried Daphnia, $1\frac{1}{2}$ ounces of ant eggs (pupæ), 1 ounce of dried powdered prawn (shrimp or lobster), 2 raw eggs together with the powdered shells, $\frac{1}{4}$ ounce of table salt, $\frac{1}{8}$ ounce of Epsom salts, and sufficient gum arabic in boiling water to bind the mass. This is thoroughly kneaded into a thick dough, dried at low temperature, and crushed into convenient particles, making about a pound of dried food. Just before

feeding the granules are steeped in lukewarm water, or they may be forced through a colander or other device to produce a vermicellilike form. It is the opinion of a good authority on goldfish that this food contains too much animal substance to produce entirely satisfactory results.

Prepared foods containing many of the ingredients mentioned are for sale in the market and their use can be recommended to the amateur aquarist. The main thing to guard against is the giving of more than the fish will consume at one feeding, as any excess allowed to remain in the water will eventually pollute it and produce diseased conditions.

Daphnia, popularly known as "ditch fleas," are an excellent live food for goldfish. The same may be said with reference to the larvæ of the mosquito, which can be had in large quantities during the summer months and may be found in rain barrels or stagnant pools, the common name being "wrigglers."

Fig. 6.—Ludwigia (*Ludwigia glandulosa*). Natural size. Prized for its beauty in the aquarium; grows from cuttings.

DISEASES AND THEIR TREATMENT.

Illness among goldfish becomes apparent in many ways, but as a usual thing the fins are bloodshot, the dorsal fin droops, and the affected fish is inclined to rest on the floor of the aquarium, with little or no desire for food. Where only one fish is diseased the cause may be attributed to overfeeding or constipation, but if a number are ill it is an indication that something is radically wrong, either with the food, the water, the oxygen supply, or the temperature conditions.

The excrement in health is dark, either a brownish green or black. If white or yellow it indicates overfeeding. When a fish becomes diseased, it should be immediately removed from the aquarium.

Goldfish must be handled gently and as little as possible, to avoid injury to their scales, fins, or tails. The dip net used for their transfer to and from the aquarium should be round and somewhat deep, rather than funnel-shaped. If it can be avoided, fish should never be grasped by the hands.

Sudden changes in temperature produce the diseases known as "white fungus" and "tail rot." When a whitish coating or splitting of the fins is noted the affected fish should be placed in another

jar containing water just salty enough to be noticeable to the taste and kept there until cured, the salt water being changed daily. This treatment is good for run-down fish as well as for those that are diseased.

To overcome constipation, dissolve a tablespoonful of Epsom salts in a gallon of water and allow the fish to remain in the solution for a few hours if necessary. Then let them rest a day or two in a mild solution of Epsom salts with a little sea salt added. Constipation can be prevented by the use of live foods, such as Daphnia, at intervals.

Fish subject to a higher temperature than that which they were accustomed to are apt to develop fungus or other diseases. When fish are brought in from the open the temperature should be gradually lowered and overcrowding should be avoided. At the first indication of fungus (white spots on the fins) the fish should be given a salt treatment, after which they should be kept apart from the healthy ones in well-aerated water.

Fungus is a parasitic plant, and species of it are always more or less abundant in the water. Healthy fish usually have the strength to resist them, but fish that have been injured by injudicious handling are liable to become affected. The fungus will be observed as black and white spots, or the fish may have most of its body covered with slime. A strong salt solution applied with a cotton swab will effect a cure in one or two treatments. There are preparations on the market that are sometimes used for painting spots made by fungus. These preparations or balsams are insoluble in water and act as a covering while the wound is healing. In their use the affected parts are cleaned and dried and the balsam freely applied with a small brush or a piece of cotton and permitted to dry for about three minutes, the head and gills of the fish being wrapped in a wet cloth while the operation is in progress. If properly done this will not endanger the life of the fish. The following methods of salt treatment are in common use:

TREATMENT WITH STRONG SALT SOLUTION.

A solution containing 13 ounces of common table salt per gallon of water is prepared. The fish are dipped up in a deep net and lowered in the salt solution where they should remain for two or three seconds. The fish are then transferred to another vessel containing well-aerated water of the same temperature as that from which the fish were taken. This treatment may be profitably repeated daily for two or three days.

TREATMENT WITH DILUTE SALT SOLUTION.

In this case the fish are placed in a 3 per cent solution of common table salt, $\frac{1}{4}$ pound to a gallon of water, and allowed to remain in the bath with aeration of the solution for 30 minutes. The fish may then be placed in another vessel containing well aerated water. If the fish show signs of distress during the half hour, by turning on one side, they should be removed to fresh water. The treatment may be repeated daily on the following two or three days.

On cloudy days even in well-conditioned aquaria fishes will come to the surface of the water to breathe, but if they do this in clear weather it is a sign that something is wrong. The trouble may be from one of the following causes: Too few plants, too high temperature, or decomposition of unconsumed food. The cause should be found and removed as quickly as possible.

Goldfish are subject to many diseases not described in this publication, among them being inflammation of the eyes, an affection of the swimming bladder, dropsy, and consumption. The last two

are usually fatal. It is not possible to enter into details concerning these diseases and their treatment. Further information on the subject may be obtained from the standard books on goldfish culture, a selective list of which is herewith appended. Many of these books may be consulted at the public libraries.

HOW TO DISTINGUISH SEX.

In goldfish as well as in other fishes the male and female are so similar in external appearance that the sex can be determined only by an examination of the internal sexual organs. The following extract from Aquatic Life will be of interest to amateur aquarists:

> Quite the first question to be asked by one desiring to breed goldfish is how the sexes may be distinguished. It has been shown that a slight difference in contour exists in the region about the anus, but it is exceedingly hard to discern, and not a few experienced fanciers will refuse to guarantee the sex of a fish based on this feature alone.
>
> When in condition to breed the distinguishing points are very evident. The male develops tubercles or "salt spots" on the gill-plates and along the first ray of the pectoral fins. These marks may be absent from the fins, and but few in number on the gill-plates. The tubercles are usually considered an infallible distinction, but are not absolutely so. Once in a lifetime a fancier may find a female with tubercles.
>
> The female, except about the anus, exhibits no sexual difference until the development of the roes causes a distention of the body, which is more evident from a top view than from the side. Other than this, it possesses no characters to distinguish it from the male. If both sexes are in the same tank, precocious males may "drive" barren females, and in that manner aid in identification, but a doubt may be cast on the certainty of it by the fact that males will sometimes drive other males.

CONCLUSION.

Cleanliness, good light, plants well distributed over the bottom, proper food in moderate quantity, scavengers, prompt removal of sick fish, and avoidance of overstocking are the essential factors for the maintenance of a successful aquarium. Thousands of goldfish have been killed by lack of observance of a few simple rules and many are lost through mistaken kindness. The globe in the sunlight is a veritable torture cell. Avoid tapping on the glass, as it frightens the fish. The fact that goldfish can endure a great deal in the way of unwholesome environment is not an excuse for torturing them. Moreover, with proper care they will thrive and attain a great age.

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PROGRESS IN BIOLOGICAL INQUIRIES, 1922.

REPORT OF THE DIVISION OF SCIENTIFIC INQUIRY FOR THE FISCAL YEAR 1922.[1]

By R. E. Coker, *Assistant in Charge of Scientific Inquiry.*

(With the collaboration of investigators.)

CONTENTS.

INTRODUCTION.

It is an original and fundamental function of the Bureau of Fisheries to inquire into the causes of the decrease of food fish and other useful resources of the waters, in order to seek means of checking decreases where they appear and of promoting increases wherever possible. Decreases of aquatic resources have occurred and are likely to continue with the increased demand upon the fish-food supply and with a growing population that steadily augments the number of possible fishermen and sportsmen.

There is indeed a conspicuous contrast between the histories of production of land and water products, respectively. While over a span of years we see with gratification a steady and noteworthy development in the yields of principal products of the land, we observe at the same time, and unfortunately with generally small concern, an entirely different trend with regard to the crops that are derived from our waters. While we grow more wheat and corn, more cattle and poultry, we have less halibut and whitefish and fewer crabs and lobsters. New regions have been opened to production of potatoes and fruit, while considerable areas of water bottom, once productive

[1] Appendix XIII to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 936.

of oysters, have become barren, and sturgeon and other useful fishes disappear. Many of our fisheries bid fair to become merely historical records.

It is notable, too, that when a serious diminution in land crops threatens there is almost invariably a prompt and compelling demand for the application of methods of scientific research to the study of causes and remedies. Appropriations and personnel are made available, so that serious losses may not continue indefinitely for lack of the services of skilled investigators or for want of proper equipment for attack upon the problems involved. On the other hand, the disappearance of useful aquatic resources has rarely awakened an effective public interest, and only a small and frequently changing personnel with very limited equipment is permitted to confront the complicated problems that concern a hundred different resources of seas, lakes, and rivers. While a diminution in the yield of corn becomes a cause for action, a decline in production of shad remains a topic for conversation.

This is not to say that the exhaustion of fishery resources is inevitable or that the decline of fisheries has not in some instances been arrested or retarded. In many cases, though not in all, effective results have been gained by the application of measures of production and propagation as far as has been permitted by the knowledge available and by the public will. Investigations pursued in the past have yielded a certain fund of knowledge regarding propagation, habits, and conditions of life of fishes, and upon such knowledge is based both the fish culture that is so extensively pursued in the United States and the great body of sound protective measures wherever in effect. Were the fund of knowledge greater, artificial propagation would be more successful and economical and would no doubt be effectively extended to other species, while protective legislation would be more wisely framed and more successful in the accomplishment of its purpose.

Never, perhaps, has there been greater demand for the application of knowledge regarding fishes to practical ends for the public good, while yet there is no proportionate demand for the discovery of the knowledge that can be given application.

During the past year the bureau has endeavored to apply its limited resources to the problems of the fishes in the most effective manner, having regard inevitably to the qualifications and experience of its available personnel and to the limited funds and equipment. The story of the progress and accomplishments in biological investigations is told in the following pages.

STUDIES OF FISHES.

ALASKA SALMON INVESTIGATIONS.

Prof. Charles H. Gilbert and Henry O'Malley conducted extensive studies of the runs of salmon in the southeast and central districts of Alaska. Special attention was given to the salmon of Kodiak Island, where a rack had been constructed in Karluk River early in the season and the counting of red salmon ascending the stream was being carried on. It was reported that up to Septem-

ber 17 the total escapement of red salmon up the river was 1,322,000. The investigations in the Karluk region were most interesting and profitable. Every spawning stream tributary to Karluk Lake was examined, and upward of 1,000,000 red salmon were observed on the very limited spawning grounds of that district. The escapement for spawning as related to the commercial catch, a subject that the bureau has under consideration at Karluk and Litnik in Alaska, as well as at Quinault Lake and Baker Lake in Washington, is receiving merited attention from the fishing interests. It is the purpose to continue the work in these fields and to extend the experiments to other favorable streams.

SALMON INVESTIGATIONS IN PACIFIC COAST STATES.

The investigation of the salmon of the Pacific Coast States has been continued by Willis H. Rich. Some additional returns of fish were obtained during the fishing season of 1921 from the marking experiments on the Columbia River started in 1917, and it is expected that others will be taken during the season of 1922, although none had been reported up to the end of the fiscal year. A statement of the first results of these experiments is contained in the report of the division for 1921. In continuation of the program on the Columbia River two new experiments involving the marking of approximately 100,000 young chinook salmon have been started.

The study of the relative maturity of the chinook salmon taken by troll and purse seine in the ocean along the Pacific coast has been completed, and the report is in the final stages of preparation. This will give in detail the data on which the conclusions are based. It has been found that the percentage of immature fish is very high early in the fishing season, averaging about 90 per cent during May and the early part of June. These figures apply particularly to the fish taken off the mouth of the Columbia River, the region that has received the most careful consideration. The percentage of immature fish decreases as the season progresses, until in August only about 20 per cent of the fish taken are immature. A similar though less marked change occurs in the catches made in Monterey Bay and off the coast of northern California. The report also includes data on the rate of growth of the salmon during their life in the ocean.

Knowledge of the general features of the life history of the chinook salmon has been materially advanced by the study of the fish taken in the open ocean. The data on the rate of growth during the life in the sea are of especial importance, since they provide a check on the results obtained from the measurements of the scales of the mature fish taken in the river. The interpretation of the scales has received much attention, and most of the more important difficulties in the way of the satisfactory determination of age and other facts of the life history have been overcome. This phase of the study has not been discussed in detail in the report on the relative maturity of the fish taken in the ocean but is reserved for inclusion with a future report on the general features of the life history.

THE WHITEFISH AND ITS RELATIVES IN THE GREAT LAKES.

During 1921 the investigation of the systematic relationships and habits of the whitefish and related species of the Great Lakes was extended to Lakes Ontario and Superior. On neither lake are fishing operations for deep-water ciscoes now carried on, either because of the exhaustion of the supply of the species originally fished for or because the existence of these species is unknown. In Lake Ontario, in addition to the two whitefishes (Coregonus and Prosopium), which occur also in Lake Huron and Lake Michigan, there were found five species of Leucichthys (ciscoes), all but one of them (*artedi*), the so-called "Lake Herring," being deep-water forms. Three of them have never been taken in the commercial nets allowed in American waters. These species were caught in abundance in the special nets set out of several ports and doubtless would support a fishery. In Lake Superior there were found one Coregonus, one Prosopium, and five species of Leucichthys. Of the latter only two (*artedi* and *zenithicus*) are known to be abundant. None of the species taken in either lake is new, and, with the exception of one from each, the coregonine fauna of the two lakes is derived from the same stock. Singularly enough, the one species of Ontario that does not occur in Superior has so far been discovered elsewhere only in Lake Michigan, where it has latterly been found to be very common during its spawning season. It is hoped to complete for publication during the coming year a comprehensive report upon the investigations, which have now been conducted for several years and the results of which should form a valuable part of the foundation of knowledge upon which must rest any intelligent attempts to conserve the fishery resources of the Great Lakes.

As is now well known, it is possible to approach the study of the biology of fishes through careful examination of the scales, and provided that sufficiently large numbers of fish are used and that due care is taken to meet the requirements of sound analysis of data, much information regarding fish may be gained in this way that it is not possible to secure by any other means. The investigation of the coregonine fishes of the Great Lakes just mentioned has been supplemented therefore by studies of the scales conducted by John van Oosten, scientific assistant, under the direction of Prof. Jacob Reighard in the University of Michigan. Conditions made it necessary to restrict attention to the various species obtained from Lake Huron. Up to the present time enough has been learned about the whitefish, pilot, blackfin, and lake herring to warrant certain general statements concerning their life histories. It has been found that the whitefish, *Coregonus clupeaformis*, is the fastest growing fish of the 10 species from Lake Huron. It attains an average length of 449 millimeters in the seventh year. For the other three species the average lengths in that year are as follows: The pilot, *C. quadrilateralis*, 295 millimeters; the blackfin, *C. nigripinnis*, 267 millimeters; and the "herring" (so called), *C. artedi*, 258 millimeters. On comparing the growth curves of these four species of coregonines for the first seven years of life it appears that the whitefish is a comparatively fast-growing fish during each of the seven years. The "herring" grows nearly as rapidly as the whitefish during the first two years, about one-half as rapidly during the third year, and much more slowly

during the remaining years of life. The pilot grows more slowly than the whitefish and herring during the first three years and approaches the rate of growth of the whitefish in the fourth and fifth years and that of the herring in the sixth and seventh years of life. The blackfin appears to grow more slowly than any of the above three species during the first six years of life. The 5 and 6 year blackfins, for example, average the same in length as the 4 and 5 year herrings; the 6-year blackfins average the same as the 4-year pilots, while the 7-year blackfin is no larger than the 3-year whitefish. After the sixth year the blackfins increase their rate of growth.

Concerning the growth of the very young specimens nothing is known from actual measurement, as these specimens are up to the present time unobtainable. The youngest specimens in the collection are 2-year herring and whitefish, 3-year pilots, and 5-year blackfins.

The maximum sizes are more or less completely represented in the collection, so that the maximum ages can be determined. It was found that the "herring" (of the four species considered) possessed the shortest life span and the whitefish the longest. The maximum ages were as follows: "Herring," 8 years; pilots, 13 years; blackfins, 13 years; and whitefish, 17 years.

Both mature and immature specimens are represented. The age at sexual maturity for some of the species seems to vary with locality. Thus the whitefish from Kagawong and Mindemoya may mature at the age of 4 years and those from Bay City, East Tawas, Cheboygan, and Gore Bay at 5 years, but those from Alpena and Killarney do not appear to mature before the sixth year. Likewise the age at sexual maturity of the pilots seems to vary with the locality. At Kagawong this species may mature at 4 years, but those from ports on Lake Huron do not seem to mature before the fifth year. The blackfins mature in their seventh year, irrespective of the port from which they are taken. The herring matures in the third year. Perhaps the pilots and whitefishes of this water are composed of different races.

In order to determine the average length of life of all the valuable coregonine species of the Great Lakes, as well as to secure more reliable data on other questions of interest concerning these fish, it is desirable that larger and more representative collections be made and studied.

FISHES OF CHESAPEAKE BAY.

The extensive study of the fishes of the Chesapeake Bay, begun just before the close of the fiscal year 1921, was continued throughout the year 1922. The field work was conducted by W. C. Schroeder, utilizing the fisheries steamer *Fish Hawk*, and the materials were studied by Samuel F. Hildebrand and W. C. Schroeder, scientific assistants, with cooperation from Prof. Edwin Linton, temporary investigator, in the analysis of the food of fishes. In the field work it is endeavored to collect not only representatives of all fishes found in the bay, so far as practicable, but to obtain fishes of all sizes and at all seasons in order to gain information upon rate of growth, spawning seasons and locations, maximum sizes obtained, and other questions of importance. Large numbers of stomachs of fish are pre-

served for investigation of the food of fishes at different sizes and in different seasons. The fishermen and dealers are interviewed and, through their cordial cooperation, much valuable information is gained for each species of fish as to its commercial importance, the periods, seasons, and years of best catches, the time, place, and manner of catching, the local names, the trend of abundance of the fish, whether increasing or decreasing, and any other facts of interest. In some cases it was possible to copy the records of pound-net fishermen for various years from 1910 to the present time. It is intended that the report when completed shall be in every way as practically useful as is permitted by the conditions of the study.

The shore work has been done principally at 15 stations on both sides of the bay, from Norfolk and the Capes to Havre de Grace in the upper end of the bay. The use of the *Fish Hawk* made it possible to conduct studies in various parts of the bay and in the mouths of the rivers, a small beam trawl being used at 68 different stations and at depths varying from 30 to 162 feet. Trawling during February revealed very few fish, small glut and branch herring predominating among the fish caught at that season. The general fishing situation in Chesapeake Bay during the past year was found to be good. While certain species have declined in numbers, particularly the bluefish and Spanish mackerel, others are maintaining their abundance in spite of increased fishing and at least one species, the croaker or hardhead, has notably increased in abundance.

MISCELLANEOUS STUDIES OF FISHES.

Incidental to other duties R. L. Barney and B. J. Anson completed during the year a study of the natural history of the orange-spotted sunfish. The report submitted by them includes a discussion of the breeding and spawning habits, the food, growth, and economic relations of the sunfish.[2] It is evident that the orange-spotted sunfish is of importance where used in the pond culture of carnivorous fish; in nursery ponds for fish-cultural enterprise it serves as an economical agent in the turnover of small and otherwise unusable material into fish flesh. Because of its feeding habits it has a value also in mosquito control. Important observations on the usefulness of this fish in black-bass culture are made available in the report.

While cooperating with the Minnesota Game and Fish Commission in matters relating to the protection of fresh-water mussels in Lake Pokegama, R. L. Barney, director of the fisheries biological station, Fairport, Iowa, and H. L. Canfield, superintendent of fish culture at the same station, found favorable opportunities for making observations on the natural history of the rock sturgeon and the sheepshead. Many data were secured concerning the food, growth, age, and weight relationships, attainment of sexual maturity, sexual cycle, and daily and seasonal migrations of both species. Such observations should have particular importance with reference to the protection of the rock sturgeon, a most valuable fish that is yearly becoming less and less numerous.

[2] Life History and Ecology of the Orange-Spotted Sunfish, *Lepomis humilis*. By R. L. Barney and B. J. Anson. Appendix XV, Report, U. S. Commissioner of Fisheries for 1922. Bureau of Fisheries Document No. 938. In press.

An experiment in the tagging of fish in Lake Pepin, September, 1921, was conducted by C. N. Blystad, scientific assistant. The number of recoveries as yet has been too small to justify conclusions regarding migrations. In two instances tagged wall-eyes were recovered at a distance of 35 miles upstream after intervals of 63 days and 4 months, respectively; while other tagged fish of that species were recaptured in the lake at the same time. The greatest distance at which a white bass was recovered was 153 miles downstream 30 days after it was tagged.

Largely by volunteer cooperation Prof. A. S. Pearse at the University of Wisconsin and his graduate students are making various studies of the feeding habits of fishes with reference to the selection and utilization of particular sorts of foods by fish, the investigation involving feeding experiments under conditions of control, repeated weighing of fish, chemical analysis of fish at various times, and studies of digestive enzymes. Other studies are directed at the functions of the swim bladders and the physiological effects of variations in temperature, gaseous content of water, and pressure.

Data on the capture of river herring in connection with mussel propagation in the upper Mississippi River over a considerable period of years have been compiled and summarized. It was hoped that the analysis of the data would throw light upon the effect of the Keokuk Dam upon the abundance of the river herring in the Mississippi River. The records indicate that there is a movement of river herring into Lake Pepin (or into the areas of seining operations) in early summer, probably after spawning. Fingerling fish of increasing size have been taken in July, August, September, and October in each of the last eight years. Relative annual frequency of the species can not be arrived at from the available data. The fish appears to be holding its own but is certainly not increasing markedly in abundance. In view of the absence from the lake of fish of intermediate sizes (6 to 12 inches in length) it must be thought either that growth is so rapid that the size interval observed is spanned between summer seasons or that the species does not frequent Lake Pepin or the areas of seining operations during the third year of its life.

The standard methods of scale study are being applied by Charles W. Creaser, temporary assistant, to sunfishes and basses with the objects of developing facts concerning the life histories of these fishes and of checking the availability and validity of the methods for application to such fish. The relation of scale growth to fish growth under controlled experimental conditions has been worked out in the bluegill and the large-mouth bass. "Year marks" also have been produced upon the scales of these fishes under known conditions. Much difference in the rate of growth in different waters has been found for certain species. Material has been collected throughout the year to determine the time of the formation of these marks. The ages of a large series of these fishes, mostly from Douglas Lake and Huron River, have been determined and many scales mounted for future measurements. It is proposed to determine for fish living under various conditions such facts as the rate of growth, age of spawning, average size at any year, maximum size, and weightage increase.

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EXPERIMENTAL FISH CULTURE.

The largest pond-culture production of buffalofish recorded has been obtained at the fisheries biological station, Fairport, Iowa, in a pond measuring 0.846 acre in surface area. From eight adult buffalofish held in this pond, which was afforded an artificial flood similar to the natural spring flood of rivers of the Mississippi drainage, 98,000 fingerling buffalofish from 2 to 5 inches in length were raised. The computed weight of these 98,000 fish was 1,753.5 pounds. The growth of the fingerling was not derived entirely from the natural food of the pond in which they were born, since many obtained a chance entrance into an adjacent pond where there was a less crowded condition. The production, however, is exceptionally large and noteworthy for any species of fish in a pond.

In recent years it has been learned by experiment that an artificial rise in the level of the water of buffalofish ponds at the time of spawning is a desirable factor in obtaining a large production of fry. The rise is meant to simulate the natural rise of the river during which the buffalofish in nature spawn. Experiments with controlled ponds indicate that the rise is not entirely necessary but that it is especially to be desired. The usefulness of the "artificial flood" in the pond culture of buffalofish of both species—the small-mouth or current buffalofish, *Ictiobus bubalis*, and the stub-nose or big-mouth buffalofish, *Ictiobus cyprinella*—has apparently been demonstrated.

After several years of successful experimental pond propagation of the buffalofish, H. L. Canfield has prepared a concise account of the information at hand in the care and feeding of buffalofish in pond culture.[3] It includes observations on space requirement of adult and fingerling fish, handling of ponds in buffalofish culture, relation of water stage and temperature to production, and observation on natural and prepared food and feeding.

Pursuant to the purpose of maintaining as close and helpful a relation as is possible between the scientific inquiries of the bureau and the practical fish-culture work, a scientific assistant was detailed to spend the greater part of the year at a fish hatchery in observing the fish-cultural methods employed, conducting experiments with alternative methods, and making studies of the fish and the conditions of their propagation and rearing. D. R. Crawford, selected for this detail, visited the Erwin (Tenn.) station in the fall of 1921 and remained there until the close of the fiscal year.

Stripping the fish with belly down and applying pressure only back of the ventral fins was tried out with results justifying the conclusion that the established method (holding the fish belly up under the left arm and passing right hand over abdomen and sides from head to vent), when carefully and skillfully applied, is better because of the lesser period of time during which the fish is subject to the operation. Injuries when manifested are probably due chiefly to lack of training, skill, or care on the part of the spawn taker rather than to defects of method. Test of different frequencies of stripping gave inconclusive results, but it appeared that two-day intervals were too frequent at the beginning though not at the height of the season; different lots of fish vary in the rate of maturing of the eggs and

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[3] Care and Feeding of Buffalo Fish in Ponds. By H. L. Canfield. U. S. Bureau of Fisheries Economic Circular No. 56. Issued December 13, 1922.

therefore in the intervals at which they should be stripped. Frequency of stripping must be determined by experience at each station and for fish of different conditions.

Attempts to strip a fish too soon may result in displacing eggs prematurely from the stroma, with the result that they become of the familiar hard glassy type and incapable of fertilization. The old dried shells found in some fish represent eggs that have been overretained, the egg substance having been resorbed, a process that may be injurious or fatal in its effects. There is also abundant evidence that retained eggs retard the maturing of eggs in the next season and cause a diminution in the number produced or even effect a temporary apparent sterility of breeders. It is therefore important for spawn takers to know just when to expect to find mature eggs in large numbers. The number of eggs yielded by rainbow trout of various sizes was found to vary from about 400 with fish of 10 to 11 inches in length to 2,500 (one instance) with a fish 19.5 inches in length.

Other observations and experiments at Erwin, Tenn., the results of which can not be given at this time, related to the production of natural food supply in ponds, the use of a hexagonal tank in place of long hatching troughs, and the effect of the alkalinity of the spring water at Erwin upon the fish that it is attempted to rear in hatching ponds.

Prof. C. B. Wilson, temporary investigator, has been engaged in completing a study of the rôle that beetles play in pondfish culture. During the past year the complete life histories of five species of beetles were added to those obtained previously. In addition to this study of the relation of beetles to pond culture Professor Wilson has begun a similar investigation of water bugs. Observations have been made on the life histories of two species of Notonecta, one of Ranatra, and one of Belostoma. Valuable observations on the food and enemies of both nymphs and adults have been recorded. Advantageous and detrimental relationships of beetles to fish have been noted, and methods of control of undesirable species have been made available.

At the instance of the Iowa State Game and Fish Commission an examination of Clear Lake, Iowa, was made by H. L. Canfield, of the fisheries biological station, Fairport, Iowa, with a view to ascertaining conditions affecting the supply of food and game fishes of the lake and to suggesting possible means of bringing about an increased game-fish production. In brief, the recommendations had reference to the development of commercial fishing for capture of rough fish, the artificial propagation of the desired game fishes, and the preservation and protection of areas of shallow water and of vegetation.

DISEASES AND PARASITES OF FISHES.

The position of fish pathologist in the bureau was vacant during the greater part of the fiscal year, so that investigations in this field could not be continuously conducted. In February Dr. H. S. Davis, formerly professor of zoology in the University of Florida and at times temporary investigator for the Bureau of Fisheries, assumed the position and devoted his attention in part to the completion of certain studies of the parasites of fishes previously brought near to

completion and in part to the study of conditions causing losses of young fish or of brood stock in fish hatcheries. A flagellate protozoan (*Octomitus salmonis*) occurring in the forward end of the intestines, sometimes in enormous numbers, was deemed responsible for the high death rate among rainbow trout being shipped from the White Sulphur Springs (W. Va.) station.

In response to a request of Carlos Avery, commissioner of the Minnesota Game and Fish Department, an investigation was made of the cause of the heavy losses of fish during the summer months of 1921 in several Minnesota lakes. The loss of fish in Lakes Bemidji, Leech, and Mille Lac was very great. Examination of dead and dying fish revealed no bacterial, fungous, or other parasitic infecting organism. All evidence pointed to the conclusion that the mortality resulted from lowered dissolved oxygen content, occasioned by the want of natural mechanical means for the introduction of oxygen; the great losses occurred during and just after an unusually extended period of great heat, with no wind or rain. The species of fish mainly affected were those that normally seek the lower and cooler and in this case, presumably, the almost oxygen-free waters of the lakes in question. The recommendations offered through B. J. Anson, who investigated the condition, had reference to an appropriate control of the fish population through the promotion of restricted commercial fishing in these lakes.

Prof. A. S. Pearse, temporary investigator, completed during the year a report of observations of fish parasites in several waters. The study was originally undertaken as one phase of an attempt to discover why fishes attain only a small size in certain bodies of water, although becoming much larger in other waters near by. The observations were at first restricted to perch from 16 lakes in 3 different river systems. Later more extensive observations were made in 5 different types of lakes where the parasites of all available species of fishes were studied. About a dozen species of parasites were discovered on the yellow perch, and approximately 95 species were found on fish of all species examined in the 5 lakes.

Lakes with the widest range of territory and with opportunity for fishes to invade the greatest variety of habitats are found to have the highest average infection per fish. Taking as a criterion the number of species of parasites showing highest average infections, the lakes rank in the following order: Pepin, Mendota, Michigan, Green, Geneva. This order indicates that there is a direct relation between variety of habitat and amount of infection. Variety of habitat is also correlated with a large number of species of parasites (and of fishes). In other words, the lake with the largest variety of habitats has the greatest variety of fishes and of parasites. It is stated as a corresponding principle that the fish that travel most and thus invade the greatest variety of habitats have the most parasites.

Arranged in order of average infection, and weighing the fish and lakes according to a formula given in the paper, the fishes in the five lakes rank in the following order: Dogfish, 90; small-mouth black bass, 78; white bass, 78; rock bass, 73; pumpkinseed, 71; sucker, 68; black bullhead, 66; tadpole cat, 64; wall-eyed pike, 61; speckled bullhead, 60; long-billed gar, 56; bluegill, 55; yellow bullhead, 55; all species of cisco, 54; large-mouth black bass, 45; pickerel,

42; carp, 40; buffalofish (*Ictiobus cyprinella*), 36; log perch, 35; blunt-nosed minnow, 32; top minnow, 32; yellow perch, 31; shiner (*Notropis heterodon*), 30; Johnny darter, 30; black crappie, 27; shiner (*N. atherinoides*), 14; bream, 11; shiner (*N. hudsonius*), 11. In general, the fishes that frequent vegetation show the highest infection with parasites; those that frequent the bottom and open water are intermediate; and the small fishes that live in shallow water have fewest parasites.

The susceptibility of the host is an important factor in determining the degree and frequency of parasitic infection. Fish parasites may show considerable specificity for certain hosts, and hosts may possess a varying degree of immunity. The black bass, for example, appears to be susceptible to many parasites that do not often attack other Centrarchidæ. Although the large-mouth and small-mouth black bass are closely related, the latter always carried more parasites. Pumpkinseed were always more heavily infected than bluegill. Some of these differences may be due to differences in habitat; some are undoubtedly due to susceptibility. A general similarity between parasites of the Siluridæ and certain of the Percidæ is noted.

Seasonal changes doubtless have a marked effect on certain parasites, but the observations are not conclusive. A previous investigator has suggested that perch had few parasites when little food was eaten on account of low temperature. In this investigation perch were found to have more parasites in winter than in autumn or summer, but it was the investigator's experience that perch did not refrain from eating during winter.

The size of the lake did not appear to be correlated with the degree of parasitic infection of its fishes. The density of the population may sometimes be of importance, but in general no direct relation was observed between number of fishes and number of parasites. On the whole, infection was found to be greater in shallow water, probably because there is there a greater variety of habitats and of secondary hosts.

The conclusions from this investigation are not stated as definitive or universal of application, but the results point to the need of more studies of the ecology of fish parasitism.[4]

During the last 8 or 10 years there has been noticed among winter-fed yearling terrapins at Beaufort, N. C., two pathological conditions, both of which lead to the death of the nonhibernating animals. It has been observed also that among those yearling terrapins that have been allowed to hibernate normally there was rarely found any symptom of disease; the only exception would be an occasional case of "soft shell." This condition, relatively common among diseased winter-fed yearlings, is due apparently to faulty absorption of the yolk sac after birth. The other death-producing condition is a disease that generally attacks the tail at its very tip and causes its rotting back to the body proper, where the disease destroys the rectum and seriously affects the spinal cord, paralysis of the hind limbs occurring and death following shortly. Often the flippers, neck, and eyes of the terrapins become affected, and this condition may result in preventing the terrapin from feeding.

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[4] The results will be published in the next volume (21) of the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters.

Bacteriological examination of the terrapin by R. L. Barney, director of the Fairport (Iowa) station, and A. Scorpio, temporary assistant, has revealed in each case a characteristic organism, a diplobacillus, varying considerably in size under different conditions. Biochemical tests of the organism have been made, and morphological and staining characteristics have been noted. The germ finds lodging in the epithelial tissue of the epidermis and in connective tissue beneath. Cultures of the organisms have been isolated and injected into healthy individuals producing death in some cases in a short time. Observations on the effect of temperature, light, salinity, and drying out of the terrapins in connection with the prevalence of the disease have been recorded. Further studies projected may develop methods of prevention of transmission of the disease or of a remedy.

STUDIES OF RIVER, LAKE, AND SEA.

CHESAPEAKE BAY.

The regular cruises planned for the hydrographic and biological survey of Chesapeake Bay were completed in June, 1921, but two additional cruises, one in January and another in March, 1922, were made in order to obtain additional data regarding the hydrogen-ion concentration or alkalinity of the water during the winter and spring as well as data concerning the occurrence of young fish and the movements of fish in general. As a result of these last two cruises and the cruise of June, 1921, evidence was obtained from tests on the 24-hour stations; first, that there are indications of a diurnal variation in the hydrogen-ion concentration of the Chesapeake water (less alkaline usually during the night); second, that the water is inclined toward acidity near the mouth of the Patapsco River and that it becomes more alkaline passing toward the Capes; third, that in the summer the alkalinity decreases rapidly passing from the surface to the bottom; and, fourth, that there is almost no difference between the degree of alkalinity of surface and bottom water during the wintertime.

During the past year a study of the hydrographic data obtained in 1915–16 and 1920–1922 show that the mixing of ocean and river waters is not complete, that the more saline water is found at the bottom, and that the waters near the eastern shore seem to have a greater amount of salt than those along the western shore, at least in the lower half of the bay; and that usually the temperature of the water increases with the depth during December and January, that it decreases with the depth during April, June, and July, and that in March and September there is little or no difference between the temperature of the surface and the bottom.

The current meter observations every 1½ hours on the 24-hour stations yielded the interesting information regarding tidal currents that at times in any one locality the water at the bottom may be moving up the bay and the water at the surface down the bay, and that at other times the surface water may be almost stagnant while the bottom water may be moving with considerable velocity either up or down the bay.

During the year arrangements have been made with the National Museum and with a number of specialists to identify the various forms caught in the beam trawl, bottom net, dredge, and surface nets. This material is being separated, and a considerable quantity has been shipped to specialists.

The purpose of this investigation is, first, to determine the normal biological and physical conditions throughout the year, so that when great mortality of fishes, oysters, clams, crabs, etc., occurs there will be normal data at hand from which to determine the abnormal conditions that bring about the trouble; second, to learn all that is possible concerning the movements of layers of water of different density, different temperature, and different plankton content (fish-food value), in the hope that the information may throw light on the migration of fishes and crabs into and in Chesapeake Bay at certain times of the year; third, to study especially the fauna of deep holes, which occur in many places; fourth, to study the so-called "barren bottoms" at the mouths of rivers; and fifth, to gather as much information as possible that will bear on the conservation of the fisheries resources of Chesapeake Bay.

LONG ISLAND SOUND.

In connection with the extremely difficult investigations of the problem of the failure of oyster set in the waters of Long Island Sound and its shores, the bureau has been in considerable measure baffled for want of the fundamental information relative to the distribution and variations of temperatures, salinities, and currents, as well as for lack of definite information regarding the extent and degree of pollutions detrimental to oyster culture and to the fisheries. It has therefore been necessary to inaugurate a hydrographic and biological survey of Long Island Sound having immediate regard to the practical problems confronting the bureau in attempting to serve the oyster industry and other fisheries. This investigation is being conducted by P. S. Galtsoff, recently appointed naturalist of the *Albatross*. Provisional plans for the work were formed in May, 1922, but circumstances made it necessary to delay the actual beginning of field observations until the beginning of the ensuing fiscal year. Since the *Albatross* has been indefinitely laid up for lack of the funds necessary to keep her in service, the fisheries steamer *Fish Hawk*, which is well suited to the purpose, will be employed in the conduct of the investigation in the field.

UPPER MISSISSIPPI RIVER.

An investigation of free-floating organisms (plankton) in the upper Mississippi River was carried out by Paul S. Galtsoff, then temporary investigator for the bureau and now naturalist of the *Albatross*. The object was primarily to obtain quantitative data regarding the fundamental food supply of fishes in the river and to throw light upon the effect of natural and artificial impounding of large rivers upon the production of food for fishes. Special attention was given to Lake Pepin, a lake formed by natural causes in the course of the Mississippi, and to Lake Keokuk, which is approximately the same size as the former lake and which has been

formed by the construction of a dam across the river between Keokuk, Iowa, and Hamilton, Mo. The investigation consisted in the quantitative study of plankton and in the measurement of temperature and transparency of water and velocity of current. Plankton collections were made with a pump, and the volume of plankton was determined by the centrifuge method. The field investigation covered a period of three months, July to September, and observations were made at 171 different stations, where 673 plankton samples were collected. The results are as follows:

Assuming that the observations made at various places and on various dates were representative, the mean content of plankton in the Mississippi River, excluding Lake Pepin and Lake Keokuk, during the period in question was 14.5 $cm.^3$ per cubic meter of water.

With regard to productivity in plankton, there is a marked difference between the upper part of the river, above Rock Island Rapids, and its lower part below the rapids. Plankton in the upper part, between Hastings and the head of the rapids, excluding Lake Pepin, averaged in August 21.3 and in September 16.2 $cm.^3$ per cubic meter of water. The corresponding figures for the lower part, between the Rock Island Rapids and the head of Lake Keokuk at Burlington, were 5.16 $cm.^3$ in July and 4.8 $cm.^3$ in September.

Comparative determinations of the amount of plankton made below and just above the rapids showed that the plankton content above the rapids was at least 2.5 times greater than below the rapids. This was possibly due to the destruction of plankton organisms when passing the rapids.

The mean plankton content in Lake Pepin was 16.6 $cm.^3$ per cubic meter of water. The lower half of the lake was richer in plankton than its upper half; the mean plankton content in the lower half being 22.1, in the upper 13.3 $cm.^3$ per cubic meter of water.

The mean plankton content in Lake Keokuk in July was 7.25 $cm.^3$ per cubic meter of water. The lower part of the lake here also was richer in plankton than the upper part, the plankton content in the upper part, between Burlington and Nauvoo, averaging 5.28, and that in the lower part, from Nauvoo to the dam, 7.7 $cm.^3$ per cubic meter of water.

The production of plankton in both lakes, Lake Pepin and Lake Keokuk, is greater than in the adjacent parts of the river.

The plankton Crustacea are very scarce in the lower part of the river, not exceeding 60 individuals per cubic meter of water; they are more abundant in the upper part, varying there from 1,000 to 46,000 individuals per cubic meter of water.

The mean number of copepods in Lake Pepin was 25,800 and in Lake Keokuk 5,400 individuals per cubic meter of water. The mean number of Cladocera in Lake Pepin was 1,020 and in Lake Keokuk 2,720 individuals per cubic meter of water. In Lake Pepin the copepods were more numerous in the lower part of the lake, while Cladocera were more numerous in the upper part. In portions of the river adjacent to these lakes the numbers of individuals of crustacean species are insignificant.

The plankton of the river is subject to great fluctuations, depending upon hydrographical conditions. During the rise of the water the plankton of the river is replaced almost entirely by detritus and

silt. In Lake Keokuk at the rise of the river stage the plankton is washed away and samples taken in this period consist almost exclusively of detritus.

The plankton of the river with regard to its composition is monotonic. The plankton of Lake Pepin and Lake Keokuk, as compared with that of the river, may be characterized as richer in Crustacea and Rotifera. No organism was found in the river plankton that would not be present in the lakes.

The increase of the production of fisheries in Lake Keokuk since the erection of the Keokuk Dam, as reported by the official statistics, can be correlated apparently with increased production of plankton in this lake.

GREEN LAKE, WIS.

The bureau has continued to cooperate in a small way with the Wisconsin Geological and Natural History Survey in the investigations of fish-food resources of small lakes. During the past fiscal year a quantitative survey of the fish-food resources of Green Lake, Wis., was conducted under the general direction of President Edward A. Birge, with the cooperation of Chancey Juday and the technical assistance of L. E. Noland and H. W. Rickett. The following summary of results has been furnished by Mr. Juday.

PLANKTON.

The standing crop of net plankton yielded an average of approximately 40 milligrams of dry organic matter per cubic meter of water from April 30 to November 3, 1921; a maximum of 58 milligrams was noted in June, and minima of 21 milligrams were found in October and November. In 1922 a maximum of 30 milligrams of dry organic matter per cubic meter of water was obtained on May 5 and a minimum of 26 milligrams on May 21. Taking the area and volume of the whole lake into account, the average crop of 40 milligrams was equivalent to 13 kilograms of dry organic matter per hectare of surface, or 11.8 pounds per acre.

The standing crop of nannoplankton yielded an average of 742 milligrams of dry organic matter per cubic meter of water in 1921; there was a maximum of 1.200 milligrams on April 30 and a minimum of 360 milligrams on April 21 and of 1,590 milligrams on May 5. For the entire lake the average crop of 742 milligrams per cubic meter in 1921 amounted to 245 kilograms of dry organic material per hectare, or 219 pounds per acre. The average standing crop of net plankton and nannoplankton combined was 258 kilograms per hectare, or about 231 pounds per acre, in 1921. The live weight of this material would be fully 10 times as large as the dry weight.

BOTTOM FAUNA.

In the quantitative study of the bottom fauna 209 samples were obtained, and the macroscopic organisms therein were enumerated; also the average weight of the various forms was ascertained, so that the results can be expressed in gravimetric as well as numerical units.

The most abundant bottom inhabitants belong to three groups: (1) Oligochæta; (2) Crustacea, represented by Ostracoda, Hyalella, and Pontoporeia; (3) Diptera larvæ belonging to the genera Chironomus, Tanypus, and Tanytarsus.

Worms were most abundant in the deeper water—that is, from about 35 down to 65 meters. A maximum of 6,800 individuals per square meter of bottom was obtained in a catch from 64 meters. This number would yield about 24 kilograms of dry material per hectare, or 21 pounds per acre. The average number for the whole lake is 436 individuals per square meter, which is equivalent to about 1.4 kilograms of dry material per hectare, or 1.2 pounds per acre. The ash amounted to approximately 10 per cent of the dry weight, and 85 per cent of the live weight consisted of water.

The amphipod Hyalella was most abundant in the shallower water, or in the 1–3 meter stratum. A maximum of 10,000 per square meter was found in one sample taken at a depth of 1.75 meters. This maximum represented a weight of about 21 kilograms of dry material per hectare, or 19 pounds per acre. The average number for the entire area between the shore line and a depth of 10 meters is 900 individuals per square meter of bottom, representing about 3 kilograms of dry material per hectare, or 2.6 pounds per acre. Approximately 20 per cent of the dry weight consisted of ash.

The amphipod Pontoporeia was found only in the deeper water, or between 10 and 66 meters; it was most abundant in the 30–60 meter region. A sample from a depth of 47.5 meters gave a maximum of 13,000 individuals per square meter, while five other samples yielded more than 9,000 per square meter. The maximum number represented about 64 kilograms of dry Pontoporeia material per hectare, or 57 pounds per acre. The average number for all of the region between 10 and 66 meters is 2,100 individuals per square meter, equivalent to 16.7 kilograms per hectare, or 15 pounds per acre, of dry material. About 14 per cent of the dry weight consisted of ash and 77 per cent of the live weight of water.

The snail population of Green Lake was found to be unusually small, by no means large enough at the present time to account for the large quantities of dead shells noted in the bottom samples taken at depths of 5 to 15 meters. Two citizens who have lived in the vicinity of Green Lake for many years reported that a large snail, which they called a "limpet" (probably *Campeloma integrum*), was very abundant in the lake a number of years ago, but at present this snail is very scarce.

A rather large mussel population was found in favorable places where the water was half a meter to 3 meters deep. This population consisted chiefly of *Lampsilis luteola.* The average number of the larger individuals was about 10 per square meter, while a maximum of 50 was noted in one locality. The maximum number represented a crop of about 18,000 kilograms per hectare live weight, or approximately 16,000 pounds per acre. The average number represented one-fifth as much, or 3,600 kilograms per hectare, or 3,200 pounds per acre. Substantially half of the live weight consisted of shell, thus leaving 1,800 kilograms per hectare for the soft part or body; an average of 91 per cent of the live body weight consisted of water, leaving 162 kilograms per hectare, or 144 pounds per acre, as

the dry body weight. About 18 per cent of the dry weight of the body consisted of ash.

The most important aquatic insects were larvæ belonging to the genera Chironomus, Tanytarsus, and Tanypus. A sample obtained at a depth of 16 meters yielded a maximum of 8,200 larvæ of these three forms per square meter of bottom. Their combined weight was equivalent to about 20 kilograms of dry material per hectare, or about 18 pounds per acre. For the whole lake bottom the average number of these larvæ was 1,148 individuals per square meter, yielding a dry weight of about 5 kilograms per hectare, or 4.5 pounds per acre. About 80 per cent of the live weight of these larvæ consisted of water and about 12 per cent of the dry weight was ash.

BOTTOM FLORA.

Mr. Rickett made a quantitative survey of the larger aquatic plants, similar to the study made by him on Lake Mendota. In Green Lake the large aquatics extend out to a greater depth than they do in Lake Mendota; the extreme limit in the former is 9 to 10 meters and only 5 to 6 meters in the latter. The averages for the various stations have not been computed yet, so that only a few of the larger catches are indicated here.

Chara was the most abundant form; a sample taken at a depth of 1 meter yielded a maximum of 10 kilograms per square meter, wet weight. Several other samples yielded as much as 8 to 9 kilograms per square meter, but most of the samples contained only 1 to 3 kilograms of Chara, or less. About 82 per cent of the wet weight of this plant consisted of water, so that a yield of 10 kilograms per square meter would represent only 1.8 kilograms of dry material, or 18,000 kilograms per hectare (16,000 pounds per acre).

Ceratophyllum and Myriophyllum were found in great abundance in some localities; one sample taken at a depth of 4.5 meters yielded 7.8 kilograms of these two plants per square meter, wet weight, and several other samples of corresponding magnitude were found. About 91 per cent of the wet weight of these two plants consisted of water, so that the 7.8 kilograms above represented only 0.7 kilogram of dry material per square meter, or 7,000 kilograms per hectare (6,200 pounds per acre).

The largest sample of Potamogeton consisted of *Potamogeton amplifolius*. The wet weight of this sample was 2.4 kilograms per square meter of bottom, of which 89 per cent consisted of water. Vallisneria was next in rank with a maximum yield of 1 kilogram per square meter, of which about 93 per cent was water.

INTERNATIONAL COMMITTEE ON MARINE FISHERY INVESTIGATIONS.

The International Committee on Marine Fishery Investigations held two meetings during the year—the first at Boston on November 4, 1921, attended by two representatives of Canada and two representatives of the United States, and the second in Montreal on May 26, 1922, attended by all representatives of the United States and Canada. On neither occasion was it possible for the representative of Newfoundland to be present. This committee, while engaging in no investigations on its own part, serves as a coordinating agency

for the marine fishery investigations of the several countries. Through the discussions of work accomplished or in contemplation and the information and suggestions gained in meeting, it is possible for functioning agencies of the several Governments to plan and conduct investigations in a manner more productive of results and more helpful to all concerned.

An illustration of the value of cooperation through this committee is afforded by the attempt now being made to gain more complete information regarding the movements of ocean waters in the North Atlantic. Plans were made for the extensive use of drift bottles put out along certain predetermined lines and as nearly as practicable at the same time. A line was to be run by Newfoundland from Cape Race across the Grand Banks for a distance of 200 miles; Canada was to set bottles adrift on lines that would run, respectively, from Sydney to Port aux Basques, a distance of approximately 85 miles from Canso to the north of Sable Island, a distance of 150 miles; the United States undertook to place drift bottles on lines running, respectively, from Cape Elizabeth across Cashes Ledge, a distance of 75 miles, from Chatham, Mass., on a course south-southeast for a distance of 150 miles, and from Sandy Hook on a course south-southeast for a distance of 150 miles. Two types of bottles are employed, distinguished merely by the depth at which is suspended a metal drag that determines the course of the bottle as it is affected by the current. The bottles were to be set adrift usually at half-mile intervals, one of each type being placed at each point. A considerable part of the program had been done by the close of the fiscal year, the fisheries steamer *Halcyon* having been employed by the United States Bureau of Fisheries for its part of the work. To judge from previous experiences in the use of drift bottles, a sufficient number of those now set adrift should be recovered to afford a substantial contribution to the knowledge of ocean currents and drifts in the northern section of the North Atlantic.

At the November meeting the committee considered and approved a form, by the use of which, beginning the first of the calendar year 1922, uniformity might obtain in reporting statistics of offshore fisheries. Plans are under discussion for beginning at an early date an investigation of the life histories of the cod and the haddock, and consideration is being given to the possibility and the best means of tagging ocean fish on an extensive scale in order that more may be learned regarding the migrations of food fishes of the sea.

At the close of the year the committee consisted of the following members: For Newfoundland, D. James Davies; for Canada, W. A. Found, Dr. J. P. McMurrich, and Dr. A. S. Huntsman; for the United States, Dr. H. F. Moore, Dr. H. B. Bigelow, and Dr. R. E. Coker.

FRESH-WATER MUSSELS.

INVESTIGATIONS OF CONDITIONS OF MUSSEL CULTURE.

At the present time the primary aims of the investigations of fresh-water mussels conducted in connection with the Fisheries Biological Station at Fairport, Iowa, are, first, to acquire the information necessary to promote economy and effectiveness of operations in the propagation of mussels by the infection of fishes that are liberated

at once in natural waters, and, second, to learn how to rear juvenile mussels from infected fish kept in confinement, with greater consistency in results, higher percentages of survival, and more rapid growth and, correspondingly, with greater economy. During recent years notable progress has been made at the station and in its field work in the rearing of young mussels from artificial infections, a task that had previously baffled all attempts. The results obtained from experiments up to the present time have not, however, been so consistent or interpretable as to justify the immediate recommendation of this type of mussel culture as a practical venture, although they are such as to give encouragement to the continuation of the experiments. In one experiment during the past fiscal year a survival of 81.5 per cent was obtained, a figure more than 10 times higher than is deemed necessary in ordinary mussel propagation to justify the practical economy of the operations in natural waters. On the other hand, in some experiments where all known conditions are supplied to yield substantial results the rate of survival is insignificant. Undiscovered factors are evidently involved. At this stage it would be folly either to desist from further trials or to fail to inquire as exhaustively as is practicable into the behavior and physiology of the young mussel and into the intricate environmental factors to which the mussels are subjected in the stages just following parasitism. Single factors must be tested out wherever it appears necessary and practicable. Among the studies of this nature that have been pursued during the past year the following may be mentioned:

Dr. E. P. Churchill, temporary investigator, made a study of the food and feeding habits of fresh-water mussels with special reference to juveniles. The facts were apparently established that in the ingestion of water-borne materials there is no choice of food particles from other substances, the ingestion of a particle brought to the mouth depending in a large measure upon mechanical factors, the size, shape, or position of the particle. Useless materials such as carmine, sand, and earth are taken into the stomach in quantities evidently proportional to the abundance of the materials in suspension in the water, but the excessive predominance of nonfood materials may be seriously detrimental to the oyster either by occupying too much space in the alimentary canal or by causing the diversion of materials from the mouth and thus checking the feeding activity. This is in accord with the results of some previous investigators dealing with other species of bivalve mollusks. Minute animals (Protozoa) as well as plants are ingested in quantities and presumably utilized. In the young mussels, at least, material passes through the alimentary canal in from two to five hours, usually in three. Foul conditions of the water may prevent mussels from opening and feeding.

Dr. A. D. Howard and B. J. Anson, working together, and C. N. Blystad have given attention to the biological and physical conditions affecting survival of the juvenile mussels, considering such factors as the free oxygen and carbon dioxide content of the water, silt in suspension or sedimentation, current at bottom, light, character of bottom, enemies (worms, insect larvæ, and snails), crowding of mussels, and unfavorable plant growths. It has been ascertained

among other things that under favorable conditions the Lake Pepin mucket (*Lampsilis luteola*) makes as much growth in the first year when kept at a density of 60 to the square foot as when planted only half as closely. In various experiments to determine the practicability of keeping young mussels in confinement during the winter a survival of 83 to 93 per cent was obtained.

Since in handling of live fish for any purpose slight injuries occur, which, if the fish are held in confinement, lead to infections by bacteria or water molds that cause the death of the fish, experiments have been made in immersing the fish in a 1 to 1,000 solution of copper sulphate after encystment of the glochidia. The results were very favorable to the fish, and the solution apparently had no effect upon the encysted mussel glochidia.

Dr. L. B. Arey continued his study of the mechanism of encystment of mussel glochidia and of the relationship existing between fish and mussel. He has been able to establish through his investigation that encystment is not the result of cell division but of cell migration; in other words, the rapidity with which the cyst of fish tissue forms about the infecting glochidium results from the wandering in and piling up of neighboring cells, not from multiplication of those present. His study throws light upon the question as to what the tissues of the host fish do, if anything, to provide special facilities for the parasitic mussel embryos. Such information may have considerable indirect value in possible improvements in methods of artificial culture of fresh-water mussels.

PRACTICAL TESTS OF THE VALUE OF PROTECTION AND PROPAGATION.

With the protective closure to mussel fishery of sections of the Minnesota River and of other Minnesota streams in the spring of 1921 for the purpose of allowing them the opportunity of rehabitating their mussel beds naturally, a statistical examination of certain mussel beds in the open and closed areas of the Minnesota River near New Ulm and Redwood Falls, Minn., was instituted.

By careful method of catch with equipment of fixed measurements and capacity, statistical information showing relative abundance and ages of shells of different species has been obtained. These data collected by Dr. A. D. Howard will serve for direct comparison with similar records collected five years hence at the close of the protective period. Such comparison should indicate the value of legislative closure of alternate sections of streams in the rehabitation of mussel-bearing bottoms.

A similar study of the Des Moines River in Iowa, closed to mussel fishing in 1920, was carried out by H. W. Clark with the same purpose in view. Careful studies are projected also for Lake Pepin, in which alternate areas are now closed or open to commercial fishing, and in Lake Pokegama, Pine County, Minn., the closure of which by administrative action five years ago has now been continued for another period.

Through the cooperation of the Hawkeye Pearl Button Co., Muscatine, Iowa, records have been obtained of the relative frequencies of the yellow sand-shell (*Lampsilis anodontoides*) and the niggerhead mussel (*Quadrula ebenus*) in commercial carload shipments from points on the White River, Ark., in the vicinity of Clarendon.

Artificial mussel propagation in large amount was carried on in this region for several years, the shells propagated being the yellow sand-shell and the mucket (*Lampsilis ligamentina*). R. L. Barney, director of the Fisheries Biological Station, Fairport, Iowa, who collected the data, has summarized them and has noted a direct correlation between the amount of artificial propagation of the yellow sand-shell and the frequency of this shell in commercial shipments six to eight years later, the attainment of salable size for this mussel requiring approximately six growth seasons. Mr. Barney's findings are also borne out by the observations of representatives of the button companies buying shells on the White River.

THE OYSTER.

Investigations relating to oysters and oyster culture were conducted during the fiscal year by J. S. Gutsell, scientific assistant, aided after the first few weeks by Herbert F. Prytherch. Besides continuing the studies, which have been prosecuted for several years in Long Island Sound and Great South Bay on the south side of Long Island, special attention was given during the winter to a relatively disastrous plague of mussels that occurred in Chesapeake Bay.

GREAT SOUTH BAY.

Investigations in Great South Bay revealed an early and exceptional abundance of larvæ, most of which appeared in two great "waves." These larvæ were to be found all over the principal oyster sections of the bay. The length of the period from attainment by the larvæ of earliest readily collectable size to attainment of setting size was found on apparently good evidence to be 10 to 12 days, with 13 to 15 days indicated for the total period from fertilization to setting. Corresponding with the distribution and abundance of the larvæ, spat was exceptionally abundant over the principal oyster area. It appeared at the time in the abundance indicated by the quantitative catches of larvæ. Soon after the setting of the second wave of larvæ, an unhealthy condition of the spat became noticeable, and a high mortality prevailed. Great loss occurred from smothering by the "sand" formation built up by Sabellaria, a tube-dwelling worm, by the sinking of the cultch into the soft bottom of certain areas and by the attacks of the drill, *Urosalpinx cinereus*. Apparently, however, the chief cause of mortality lay in some condition of the bottom that brought about a stunted condition and death of such spat as was not elevated above the very bottom by its position on the cultch. Much of the bottom was found to consist of a black muck, evidently of high organic content and smelling strongly of hydrogen sulphide supposed to be poisonous and known to be highly oxygen consuming. Although it seems probable that such a condition of the bottom must be detrimental to the spat, all attempts made in conjunction with the Bureau of Chemistry to find a reduced oxygen content of the bottom layer of water failed. Later laboratory experiments were similarly inconclusive, although the mud was found to bring about very rapid oxygen reduction under certain conditions and to yield great quantities of gas.

Great quantities of spat, which were to have been shifted to other grounds in September, were practically all dead when operations

began early in the month. On the other hand, oyster spat on elevated cultch used in certain experiments was found to grow rapidly. This suggested the probable desirability of changing the planting of shells for a set of oysters to the use of other forms of cultch that will keep the young oysters above the bottom. It is expected that following the advice of the investigators of the bureau, elevated cultch, such as brush and suspended netting, will be tried in a commercial way by planters in Great South Bay during the season of 1922.

LONG ISLAND SOUND.

Investigations in Long Island Sound were delayed by the continued study of the exceptional conditions in Great South Bay. When full attention was directed to the section extending from Bridgeport to New Haven, it was found that oysters had spawned exceptionally early, that by the middle of July oyster larvæ had already attained to setting size, and that small oyster larvæ were more abundant and more generally distributed than usual in these waters. Very soon, with a change from bright and warm to rainy and chilly weather with easterly winds, the larvæ disappeared. Although the weather and water again became warm and the oysters were found gradually to be releasing their "spawn," no spawning "wave" was evidenced, and larvæ failed again to appear in appreciable numbers. In accordance with the indications of these findings, the very limited light "set" was very early indeed for the region. While the search for larvæ was in progress a temperature survey was made for the purpose of locating areas for possible early spawning oyster beds. Although, when the work began, the season was too far advanced to permit a study of the most critical, prespawning period, the observations pointed to a distinct superiority of a number of inshore regions for the successful spawning of oysters because of the higher temperatures prevailing. Corresponding with reduced industrial activity, as compared with conditions during the war period, and a presumed diminution in discharge of trade wastes, there was evidence of improvement of the conditions of various inshore waters.

In another place (p. 13) reference is made to the necessity for more complete and definite knowledge regarding physical and biological conditions, as well as concerning pollution of waters in regions of oyster culture, and to the arrangements that have been made for securing the required information.

CHESAPEAKE BAY.

The Chesapeake Bay investigations, made in December, 1921, and January, 1922, by J. S. Gutsell, scientific assistant, were concerned with the mussel plague in the Maryland section of the bay and its tributaries. In a large part of this area hook mussels, *Mytilus hamatus*, were so abundant on the oysters as to make the cost of marketing the oysters almost if not quite prohibitive. It was soon found that in Maryland mussels were most abundant in the upper fresher part of the bay and in the rivers and were absent or insignificant in the lower, saltier waters, including Tangier Sound. It was also found that, presumably because of the clear and dry

summer and fall, the salinity of the rivers and the upper part of the bay was much above normal. An apparent correlation between the distribution of the mussel and salinity was found. With the abnormally high salinity, the hook mussel extended as far toward fresh water as oysters occur, or a very little farther, but not to a freshness equal to that which is usually to be found at the upper limit of oyster's growth. In the streams it was found to extend as far toward salt water as is represented by a surface density of 1.0121 to 1.0127. The evidence of these data seems strongly to indicate that the distribution is limited to a rather short range in salinity and that the presence of the mussels in numbers in a large part of the area was made possible by the preceding dry season and the consequent increase in salinity. Nothing definite was learned of the cause of the remarkable abundance of the mussels. The mild preceding winter and the lack of extremely strong spring freshets are possible contributing factors.

POLLUTION OF WATERS.

During recent times no subject has been of more acute interest to fishermen and dealers in fishery products than that of pollution by oils and industrial wastes. The conditions that notoriously prevail in many rivers and that occur, spasmodically at least, in other streams and at various points of the seacoasts are proper cause for concern not only to fishermen and to all interested in the fishery resources, but also to consumers of water, to bathers, and to farmers and other property owners. As relating to the fisheries, few subjects are more complex and needy of special personnel and equipment for effective investigation. There is evidently required for the adequate study of practicable means of alleviation of effects of pollutions upon fisheries a special provision of funds. Although in the absence of such provision the bureau has not been able to conduct continuous studies of pollutions it has endeavored, as opportunities afforded and means permitted, to contribute to a solution of the problems involved. Allusion has been made on another page (p. 13) to the special attention that will be given to the matter of pollutions as affecting oyster culture and fisheries in Long Island Sound.

In October and November, 1921, Carl L. Hubbs, curator of fishes in the museum of zoology, University of Michigan, investigated the pollution of the streams of the Saginaw water drainage in central Michigan. The studies were made for the Bureau of Fisheries in cooperation with the University of Michigan and the Michigan Department of Health, and much of the field work was done in company with E. F. Badger, chemical engineer of that department. Particular attention was given to the several large sugar factories that are located on the Saginaw River or its tributaries. Little evidence was found to indicate that any definite toxic wastes are responsible for the death of fishes in the streams studied; most of the wastes are of the oxygen-consuming type and kill fishes by depleting the water of its natural supply of dissolved oxygen. Both sanitary sewerage and the sugar-plant wastes are of this type. Below the smaller cities containing sugar plants the sugar wastes are of the greater importance in the pollution of the streams, while on the Saginaw River

itself both of these major sources of pollution are of critical significance; on the Flint River the sanitary sewerage (with minor industrial wastes) is responsible for a serious case of stream pollution.

The relation of stream pollution in this region to death of fishes, to angling, to the commercial fishery interests, and to water supplies, health, and recreation was given as much consideration as time allowed. A general report of the investigations was made, including data otherwise obtained by the Michigan Department of Health, as well as those secured in the study here reported. A further report is planned by Messrs. Badger and Hubbs, to be submitted when certain additional data are at hand.

At the request of the Illinois State Natural History Survey the United States Fisheries Biological Station at Fairport, Iowa, entered into cooperation with that organization and with the United States Public Health Service and the Chicago Drainage District in a study of the effects of pollution and of reclamation of submerged lands along the Illinois River upon public health and recreation, upon agriculture, and upon the aquatic resources of the river. The special part of the Bureau of Fisheries was to obtain statistical data on the fisheries of the river for 1921. These data, to compare with earlier records, were obtained by H. C. Minch, foreman of the Fairport station, by examination of railroad and steamboat express and freight records of shipments from and to the towns along the river. The survey data are now being summarized for preparation in report form by R. L. Barney.

FISH AS AGENTS IN MOSQUITO CONTROL.

Investigations of fish in relation to mosquito control were continued from previous years by Samuel F. Hildebrand, scientific assistant, working in cooperation with the United States Public Health Service. The experiments were conducted in the vicinity of Augusta, Ga., where there are numerous waters especially suitable for the investigations. The work of previous years was mainly conducted in localities where antimalaria campaigns were under way and where immediate practical results were the chief aim; but in 1921 no antimalaria work was attempted by local authorities outside of the city limits of Augusta so that the investigator had full opportunity for experiment and observation.

The highly efficient mosquito control that Gambusia provides in bodies of water in which no barriers between the fish and the immature mosquito exist has already repeatedly been demonstrated; therefore the season of 1921 was devoted mainly to the study of the relation of barriers formed by plants to mosquito control by the use of fish.

It was determined that, in the vicinity of Augusta at least, the "silver-leaf grass," *Hydrochloa carolinensis*, affords mosquito larvæ the most effective protection against fish. Other plants that sometimes seriously hinder efficient mosquito control are Myriophyllum, Potamogeton, and some of the algæ. Plants of minor importance in relation to mosquito control are cat-tails, burr weeds, arrowheads, smart weeds, and various tall grasses and sedges. Plants that appear to be beneficial are the duckweeds and the bladderworts.

In case of ponds that contain many Gambusia along with effective plant barriers it was learned that the degree of control could be

considerably increased, although complete control was never attained. In two other experiments when the fish were killed in ponds containing barriers mosquito production increased at least eightfold in one instance and ninefold in the other, as indicated by a comparison of counts made of immature mosquitoes taken in weekly dippings in the fishless ponds and similar dippings made in the "control" ponds. It appeared then that even if effective barriers are present a great reduction in mosquito production is brought about by the fish.

The most practical way of manipulating the various plant barriers in order to render them useless as protectors of mosquito larvæ requires much more study, but it was found that half measures in the removal of silver-leaf grass were more detrimental than none at all. The grass affords more protection to mosquito larvæ when it is merely thinned than when it is more rank. Again, after cutting, the plant becomes effective in protecting mosquitoes just at the moment when its growing stem attains the surface of the water. The experiments showed that, if the removal of silver-leaf grass is undertaken, the work must be thoroughly done and repeated as soon as the plant again appears at the surface.

REDDENING OF SALT FISH.

A few years ago the bureau conducted investigations of the causes and possible remedies for the red infection of salt fish, a condition that causes substantial losses to packers of salt fish on the New England coast. The investigations threw much light upon the causes but developed no practicable means of prevention.

With the beginning of the fiscal year 1922, the investigations were resumed with the employment of Alfred A. Ellsworth, of the Massachusetts Institute of Technology, as investigator. During the year the work of the investigator was devoted largely to developing the special bacteriological technique and the studies of various single factors of growth under laboratory conditions. Progress has been made in acquiring information regarding the causative organisms, but a report of results must be deferred until the investigation is further advanced.

THE BIOLOGICAL LABORATORIES.

Because of the limitation of funds and the corresponding inadequacy of personnel, both permanent and temporary, the biological laboratory at Woods Hole, Mass., was not operated by the bureau during the summer of 1921. That the station might not, however, fail to serve a useful purpose during that season it was deemed proper to extend the use of the laboratory rooms to the Marine Biological Laboratory of Woods Hole upon the understanding that no charge would be made by that institution for the use of Government facilities and that no expense to the Government would be involved. In the early part of the summer of 1922 the laboratory was reopened, Dr. R. E. Coker, assistant in charge of scientific inquiry, acting as director for the greater part of the season. From the station, as laboratory headquarters, there is being conducted by Dr. P. S. Galtsoff the biological survey of Long

Island Sound previously mentioned (p. 13). Charles J. Fish, attached to the laboratory as temporary assistant, was engaged in studies of the daily, seasonal, and annual variation of plankton (the basis of fish-food supply) in the waters of the Woods Hole region, his investigations being based upon his own observations and upon the collections and extensive records left by the late Vinal Edwards. Before the close of the fiscal year it had been arranged for Dr. Hugh M. Smith to continue his previously extensive studies of fishes of the region with a view of bringing together all records on the subject and of preparing an annotated list of the fishes. Arrangements have also been made to extend the facilities of the laboratory to a number of volunteer investigators.

The Beaufort (N. C.) biological station has continued during the year to be without a scientific director, since the salary attached to the position has not attracted the services of a person of proper training. The buildings and grounds have been brought into a condition of good repair and the buildings repainted with two coats. At slight expense repairs have been made to the sea wall on the northeast side of the island. The experiments in terrapin culture are being continued under the management of Charles Hatsel, acting superintendent. The facilities of the station have been utilized during a considerable part of the year by the Bureau of Construction and Repair of the Navy Department for investigations relating to the prevention of the fouling of the bottoms of vessels. On certain occasions also the facilities of the station have been extended to independent investigators.

At this station it is very desirable that there should be constructed a concrete wall on the northwest corner of the island to insure the retention of the level made-land on that part of the island; but the principal need of the station is a staff of investigators to enable the laboratory to fulfill the functions for which it was established and for which, presumably, it is maintained. This can be done only with the provision of appropriate salaries. The salary of the director at present is substantially less than is offered in low grades of assistantships in State universities.

The Fairport (Iowa) biological station, under the direction of R. L. Barney, has been in operation during the entire fiscal year and its activities in several fields have been mentioned on previous pages (Studies of Fishes, p. 2, Experimental Fish Culture, p. 8, Diseases of Terrapin, p. 11, and Fresh-water Mussels, p. 18). The most notable physical improvement during the year has been the installation of an electric-light plant for the cottages on the hillside, a measure long needed for the removal of fire menace. The laboratory and grounds are in good condition, but all frame buildings are in need of paint and minor repairs.

During the first two months of the fiscal year Dr. H. S. Davis served as director of the Key West (Fla.) biological station, giving special attention to the parasites of fishes of the region. During the remainder of the year the station has been without a technical staff, since the salaries offered are inadequate to retain the services of trained men.

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FISHERIES PROSECUTED BY CALIFORNIA FISHERMEN IN MEXICAN WATERS.[1]

By R. A. Coleman, *Agent, U. S. Bureau of Fisheries.*

As there is no natural boundary on the Pacific coast marking off the dividing line between the waters of the United States and Mexico, and since the conditions immediately north and south are almost identical, it is not to be wondered at that fishermen have been accustomed to ignore the existence of such a line. Records of occasional visits are to be found as far back as it is possible to pursue the inquiry. As illustrating this fact quotations may be made from appendixes to early issues of the Report of the Commissioner of Fisheries, United States Commission of Fish and Fisheries. In an appendix to the Report for 1888, J. W. Collins (1892), speaking of the fisheries of San Diego County, says:

> The fishing grounds for bonito and barracuda can not be definitely described. In general, however, they extend along the coast from north of San Diego to a long distance southward, off Mexico. Sometimes, when fish are not found in abundance near the home port, the vessels go from 200 to 300 miles to the southward for fares * * * [p. 28].
>
> The Chinese engaged in the junk fishery work chiefly among the islands and along the coast of Mexico, where they gather abalones from the rocks. Abalones were formerly abundant in the vicinity of San Diego, but the local supply has been exhausted. The fishing grounds principally resorted to by the Chinese, therefore, may be said to be off the Mexican coast. * * * Bartoleme Bay [Turtle Bay], Lower California, is a favorite resort for the junk fishermen [p. 31].

In an appendix to the Report of the United States Commissioner of Fisheries for 1893, William A. Wilcox (1895) says:

> Year by year the Chinese have been withdrawing from the business [of fishing], deeming it too hazardous on account of the danger of seizure by the Mexican Government for illegal fishing, and the possibility of not being permitted to reenter the United States [p. 188].

References of similar purport from other sources might be multiplied, especially in regard to whaling, sealing, etc., which were at one time prosecuted extensively along the Lower California coast. In all statistical records, however, except those compiled since 1918, almost no attempt has been made to distinguish between fish taken south of the line and those taken in waters of the United States. The catch has been credited without comment to the places where landed. Naturally, since it is right at the border, San Diego has received the largest proportion of these fish, which have been reported as from that place.

Until 1907 or 1908 the proportion of fish taken south of the line was comparatively small, owing to their abundance and the ease

[1] Appendix XIV to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 937.

with which they were captured in the north. With the growth of population in California, the increase in the number of fishermen, and the expansion of the gear, followed by the growing scarcity of fish, it became necessary to go farther afield, and naturally to push to the south, where the population was small and almost no fishing was done. As a consequence the business of fishing in Mexican waters has become every year of greater importance, and fishermen are looking more and more toward the still comparatively virgin fisheries of Lower California.

It may be accepted that the year 1907 marks the period when this fishing became a general practice, when a few small power boats, 25 to 30 feet in length, were sent into Mexico regularly. These boats went at first only a short distance south of the border. Ensenada, or Todos Santos Bay, was the first limit, this being soon extended to Cape Colnett, below which for the first two years they hardly ever went, being deterred by the impossibility of taking their fish to market in fit condition, the boats being too small to permit the carrying of ice and there being no means of preserving the fish for any length of time.

At first, as long as the fishermen kept away from the ports of Ensenada and San Quentin, the only places where officials of the Mexican aduana, or customs service, were stationed, they were troubled comparatively little by the constantly varying dues. Later patrol boats were put on and a close watch kept of all operations along the coast. Since 1916 the Mexican Government has had a resident agent at San Diego, and since 1917 one also at San Pedro, from whom all boats operating in Mexican waters must obtain a permit and to whom reports of the catches of fish and arrangements for the payment of dues, etc., must be made. This is in addition to the usual clearances from Ensenada and other customs ports.

Any boat clearing for a Mexican port is considered, when it returns with fish, as having Mexican fish on board, no matter whether caught within or without the 3-mile limit. Failure to pay the Mexican export duty on the entire catch is punished by the refusal of the Mexican consul to issue a permit on the next application. As a matter of fact, it is a somewhat serious thing for a boat to be caught "poaching" in Mexican waters without a permit. Fines as high as $500 are imposed in such cases, with confiscation of the boat if not paid. As a consequence some fishermen have preferred to put their boats under Mexican registry, paying $25 per month per boat for the privilege.

The boats now (1920) in use are of much larger capacity than those first sent out. They vary in length from 40 to 75 feet, cost from $4,000 to $12,000, are equipped with engines of 35 to 80 horsepower, and are serviceable, excellent sea boats, capable of undertaking any voyage within the limit of capacity of their supplies. These boats carry a supply of ice for preserving their fish, and as a consequence make much more extended trips than formerly, often going as far south as Cedros Island, or even occasionally to Magdalena Bay. Their gear usually comprises trammel nets, although they often carry paranzella nets to drag for the so-called halibut (*Paralichthys californicus*), and also gill nets for taking barracuda, sea bass, etc. The trammel net formerly consisted of only 10 to 15 "pieces." Nowadays, with larger boats, carrying 5 to 15 tons of ice, methods

have materially changed. Nets consist of as many as 52 pieces, and plans are laid, if not already utilized, for still larger ones. Their cost ranges from \$3,000 to \$4,000 per net. The linen thread of which they are made is brought from the Eastern States, but the weaving is usually done by the fishermen, this occupation employing quite a few men. When properly cared for, nets last as long as three years, and boat owners aim generally to replace about one-third of their gear each year. Proper tanning is the chief factor in the life of a net, barring, of course, loss by storm or tearing by sharks. The cost of gear is therefore a serious item of expense to the fishermen.

The number of boats operating in these waters may be placed at 60 or 65, but during the tuna season only about half that number engage in fishing in Mexican waters. This number may be largely increased in the future, as it is known that many fishermen from San Francisco, Puget Sound, and Alaska are considering the transfer of their operations to Lower California. In September, 1918, the F. E. Booth Co., of San Francisco, sent the *Ituna*, a fully equipped otter trawler of Scotch build, 201 gross tons, carrying a crew of nine men and six fishermen, to the south to test the possibilities of successful operation. After trials carried on for several months in both southern and Lower California waters the results were so indifferent that the vessel was withdrawn. It is understood that much of the trouble arose from rough bottom, with consequent tearing of the nets.

In the latter part of 1918 the average take of fish in Mexican waters by California fishermen was 700,000 pounds per month, on which an export duty of \$3,500 was paid, boat charges, clearances, etc., being additional. The take of fish varies much from time to time and is probably much larger at present.

There has been some attempt to carry on canning operations in the south. The Van Camp Sea Food Co., of San Pedro, in 1917 and 1918, sent a floating cannery, the *John G. North*, with a tender and fleet of small boats to Magdelena Bay and Cape San Lucas, at the tip of the peninsula, with some success, packing mostly yellowtail, yellow-fin tuna, etc. The *North* was unfortunately destroyed by fire, and no further operations have been carried on.[2] A cannery, which is "packing lobsters, shrimps, and sardines, and also canning turtle soups and steaks,"[3] has been in operation for some time near La Paz, in the lower part of the Gulf of California. Consideration is now (1920) being given to the establishment of other canneries along the Mexican coast.

The governor of the northern Province has projected a railroad to extend from Mexicali, where it connects with the railway systems of the United States, to San Felipe, the most northerly harbor on the Gulf of California, which will probably be built within a few years. This road is meant to tap the fisheries and other resources of the Gulf, which are known to be very great.

It is estimated that of the important food fishes now (1920) being brought into southern California the following proportions are taken in Mexican waters, the balance being secured north of the line:

	Per cent.
Halibut (so called)	80–90
Barracuda	75
Sea bass (white)	60
Rockfishes	10

[2] The Van Camp Co. operated a floating cannery in the same waters during 1921 and 1922.
[3] Item in San Diego newspaper.

Boats coming from Mexican waters frequently bring huge cargoes. The *Veribus Unitus*, in 1918, entered San Diego harbor with 40 tons of fresh fish, including barracuda and bonito. In addition to this big catch the boat had been compelled to give 6 tons to another boat for lack of space. About the same time another boat brought in a 31-ton catch of barracuda and bonito. Similar catches are occasionally reported. When fish are plentiful there is a tendency to overload the boats and thus cause deterioration or even loss of the cargo. Heavy losses are sometimes met, especially when the boats are delayed by adverse circumstances and when there is a shortage of ice.

The numerous bays and "esteros," or lagoons, that fringe the Lower California coast, together with the almost continuous "fishing shelf," or zone of water less than 100 fathoms that stretches nearly the whole length of the peninsula, afford very favorable conditions for fish life. Almost all the fish taken in southern California waters occur in equal or greater abundance south of the Mexican border and later in the season. It seems that as the season advances the fish migrate largely to the warmer waters of the south and in many cases may be taken there during the entire winter season. This fact has had no little influence in inducing California fishermen to extend their operations into Mexican waters.

The albacore, or long-finned tuna (*Germo alalunga*), alone of the fish especially sought in the north, has not been taken south of Cedros Island. The other tunas, yellow-fin and blue-fin (*Germo macropterus* and *Thunnus thynnus*), the so-called halibut (*Paralichthys californicus*), the barracuda (*Sphyræna argentea*), the white sea bass (*Cynoscion nobilis*), the jewfish or black sea bass (*Stereolepis gigas*), the yellowtail (*Seriola dorsalis*), the mackerel (*Scomber japonicus*), the bonito or skipjack (*Sarda chilensis*), the Spanish mackerel (*Scomberomorus sierra*), and others are found in great abundance and in some cases all the year round in Lower California waters. All the fish mentioned spawn in these waters, and considering the great extent of the fishing grounds it will probably be many years before the effects of intensive fishing will be seriously felt.

What has been said of the abundance of fishes is also true of crawfish, turtles, and abalones. The turtle is rarely taken north of the boundary line, and the others are so nearly fished out in United States waters that the catch is small.

Approximately 85 per cent of the catch of sea crawfish or spiny lobster (*Panulirus interruptus*) brought into southern California is taken in Mexican waters. The annual arrival is estimated at about 4,000,000 pounds. In 1918 there were about 45 men, mostly Japanese, divided into 15 or 20 camps, engaged in taking spiny lobsters along the Lower California coast. The number of camps varies from year to year, and it often happens that abalone and turtle fishermen take spiny lobster as well. In 1918 at Santa Rosalia, in the Gulf of California, spiny lobsters were selling for 5 cents apiece, or 2 cents American money, and were a drug on the market. At the same time in San Pedro and San Diego the dealers were paying the fishermen 20 cents a pound for these crustaceans. In an endeavor to prevent the extinction of spiny lobsters south of the line the Mexican Government declared a close season running from

March 1 to October 15, which does not appear to be strictly enforced, as these crustaceans are still (1920) coming in at all seasons.

It is a theory with some fishermen that spiny lobsters grow an inch a year. Thus, a 9-inch spiny lobster is 9 years old. It is said that they begin to spawn when 3 years old. They spawn in May, June, July, and August, and it is the custom of the fishermen at this time to pull the spawn off the females when caught, as the dealers will not accept them with the eggs attached. The stomachs of mackerel are sometimes found gorged with spiny lobster spawn, showing that they are great enemies of this crustacean. As a general rule, the large specimens of spiny lobsters are males and the smaller ones females. Three kinds are distinguished—the very dark colored, the red, and the very light. This distinction seems accidental, due possibly to the environment.

The number of turtles (*Chelonia agassizii*) brought into southern California is increasing. They are captured almost altogether along the Lower California coast and are usually shipped alive. The favorite locality for their capture at present (1920) is San Bartolome, or Turtle Bay, although Magdalena Bay is also much resorted to. The Gulf of California, however, will eventually be the chief source of supply, as turtles occur there in great numbers and are often of large size. A conservative estimate of the number brought in may be placed at 5,000, of an average weight of 50 pounds, although a weight of 300 pounds or more is not uncommon.[4] They are mostly taken at the spiny-lobster and abalone camps. Of late considerable attention is being given to the canning of turtle soups and steaks, which are received with favor by the trade. A turtle cannery on San Diego Bay has two vessels bringing in turtles. A considerable trade has also sprung up in the importation of turtle oil, which is used in the manufacture of high-grade soaps and cosmetics.

The take of abalone is now (1920) confined almost altogether to the Lower California coast. A Japanese firm of San Diego has controlled the abalone business in the south for many years and has 40 or 50 men engaged in the fishery. They form camps of 5 or 10 men, who move from place to place. They aim to return each year but sometimes miss one or even two years. The product amounts to 80 or 100 tons of dried meats per year, valued at 35 cents per pound, or $700 per ton.

The fishermen generally use a water glass for locating the abalone and then scrape them off the rocks with hoelike instruments. The abalone, however, are frequently in water too deep for this method or are wedged in crevices or located under ledges. To obtain these, the men resort to diving, usually in diving suits, but sometimes naked. Some of the camps are quite large. One on Northeast Bay, Cedros Island, visited in 1916, had nine persons. After cleaning the abalone and removing all refuse the meats are boiled for a short time in salt water, usually with a little lye added to produce the dark color that the oriental trade demands—to which trade most of the product goes—and are then dried in the sun. The drying trays or racks in this camp were arranged in four rows, each over 150 feet long by 3 feet wide, and were elevated about 3 feet from the ground.

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[4] According to Van Denburgh (1922, Vol. II, p. 996): "Large specimens may weigh 500 or 600 pounds, but the average is much less."

The meats are turned frequently and when very dry and hard are packed in sacks for shipment. Some dried fish was also observed.

Before the war large quantities of the abalone shells were shipped to the Orient and to Europe, principally to England, whence they were distributed to button makers, etc., throughout the continent. Since the war put a stop to the industry the trade has languished, although it is showing signs of reviving. The quantity now (1920) being brought from Lower California amounts only to 20 or 25 tons per year, its value ranging from $60 to $120 per ton, according to quality. The shells are distinguished as the blue, sometimes "green" (*Haliotis splendens*), the red, the pink, and the black—the blue or green being the most valued. It is said that the best green shell on the market comes from New Zealand. Occasionally a shell is found that yields the so-called "pholas," or blister pearls, which are sometimes of considerable value. Many shells are polished for ornaments or curios, pieces of shell being used for shell jewelry, etc. The larger proportion, however, is used for other commercial purposes.

On account of the frequent changes in the fiscal policy and the methods of collecting boat and other charges on the part of the Mexican authorities, it is not easy to present a complete or satisfactory statement of conditions. However, as an indication of the conditions under which fishing in Lower California waters is carried on, the charges in March, 1918, upon a 5-ton boat that fished below the border will serve to illustrate. They were as follows:

Security deposit ($50 returnable at end of year)	$75.00
Operation charges, each boat per month	15.00
Boat clearance	15.00
Broker's fee	10.00
Clearance at Ensenada, each trip	12.00
Export duty payable:	Per kilo.
Fresh fish	$0.01
Salt fish	.015
Dried fish	.015
Cooked lobster	.03
Live lobster	.025
Live turtle	.015
Dried turtle	.03

These items, duty not included, brought the annual expenses per boat to $600 or more. It was also demanded that the duty be paid in "papel infalsificable," the depreciated currency of one of the Government issues, which the dealer had to purchase for the purpose. Later these charges were increased about 100 per cent. An attempt is now (1920) being made to stabilize and simplify these charges and to have a commissioner appointed with an office at San Pedro, in order to bring about closer cooperation.

It is suggested that fishing might be carried on with success at the island of Guadalupe, which lies 120 miles off the coast of Lower California. In 1916 yellowtail, barracuda, mackerel, and smelt were observed in great schools, and it is said they spawn there. It would seem that an occasional boat, at least, should find it profitable to visit the locality.

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LIFE HISTORY AND ECOLOGY OF THE ORANGE-SPOTTED SUNFISH, LEPOMIS HUMILIS.[1]

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Contribution from the U. S. Fisheries Biological Station, Fairport, Iowa.

CONTENTS.

INTRODUCTION.[2]

The orange-spotted or red-spotted sunfish, *Lepomis humilis* (Girard), is a small, highly colored centrarchid of wide distribution. It is found throughout the Mississippi drainage, being recorded particularly from Ohio, Indiana (Hay, 1894), Illinois (Forbes and Richardson, 1908), Minnesota (Cox, 1897), and the Dakotas, Kansas (Cope, 1868), southward to Kentucky (Jordan and Evermann, 1896), Arkansas (Girard, 1857), Louisiana, and Texas. It is especially abundant in small sandy streams of the lower Missouri basin (Jordan and Evermann, 1896) and is well adapted to both stream and pond life, in which it is possibly of considerable significance in the economy of the habitat.

The fish was originally described by Girard (1857) in 1857 from specimens taken from Sugar Loaf Creek in Arkansas under the name *Bryttus humilis.* Cope (1865) in 1865 described a sunfish from Lake Whittlesey, Minn., very similar to the present *Lepomis humilis*, but called it *Bryttus oculatus.* In 1868 he (Cope, 1868) described the species *L. anagallinus* from Leavenworth, Kans. In 1876 Nelson (1876) studying Illinois specimens called the fish *Ichthelis anagallinus;* in 1878 Jordan (1878) changed the generic name to Lepiopomus. Jordan and Gilbert (1882), in their "Synopsis of the fishes of North America," recognized the above-

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[1] Appendix XV to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 938.

[2] The authors gratefully acknowledge the suggestions and criticisms of Dr. R. E. Coker and the assistance given by H. L. Canfield in bringing to their attention certain material discussed herewith. The photographs accompanying this report were made by J. B. Southall, the graphs by H. G. Gould.

mentioned Arkansas, Kansas, and Illinois sunfishes as identical and called the species *L. humilis*. Under this name the orange-spotted sunfish has been known to the present time. Boulenger (1895), in his "Catalogue of fishes of the British Museum," mentions the fish under the name *Eupomotis humilis*.

ECOLOGY.

Although *Lepomis humilis* has been described particularly as a stream fish, it has come under our observation more especially as a pondfish at the U. S. Fisheries Biological Station at Fairport, Iowa, and as a common species in the quiet winding bayous of the delta country of northern Louisiana, particularly in Walnut Bayou, near Mound, in Madison Parish. The species in the Fairport ponds was introduced into the reservoir of the station by direct pumpage from the Mississippi River. Since its accidental introduction into the artificial experimental pond system of the station it has flourished and has become a persistent species even where it has been associated with carnivorous fishes. In Louisiana it was captured regularly in monthly collections of fishes taken in connection with an investigation of the relation of fish to mosquito control.[3] There it was commonly associated with *Gambusia affinis*, *Pomoxis annularis*, *Lepomis pallidus*, *Abramis chrysoleucas*, *Dorosoma cepedianum*, *Ameiurus nebulosus*, and occasionally with *Chænobryttus gulosus* and *Micropterus salmoides*. It frequented the shallower water of the bayou and was most abundant in the impounded sections of the stream from which all submerged, floating, or overhanging vegetation had been removed and in the areas where clumps and thickets of willows broke the surface but in which the water was seldom clear and contained no submerged vegetation.

In impounded sections of Walnut Bayou, Mound, La., the frequency of the species was 14.[4] In the borrow pits outside the Mississippi River levees the frequency was 3.7. In "wild" and cleared sections of Walnut Bayou the frequencies were 1.7 and 1.4, respectively, while in Cypress Bayou (Barney and Anson, 1920), a near-by stream characterized by heavy surface and submerged growths, respectively, of Lemna, Spirodela, and Wolffia and Ceratophyllum, and by colder water, the frequency was 0.6. In a woodland lake, in which occasionally submerged algæ obtained a temporary foothold and where *Lepomis cyanellus*, *Abramis chrysoleucas*, and *Aphredoderus sayanus* were very numerous, the frequency was 1.1. The species from our observations prefers a sluggish stream or pond in which there is a scarcity of vegetation. Muddy or cloudy water, although not necessarily a preference, is not disadvantageous to the species.

Forbes and Richardson (1908) have found the orange-spotted sunfish most frequently in Illinois in creeks (2.06 frequency),[5] next in small rivers (1.51), and then in lowland lakes (1.19), none at all

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[3] The authors were engaged as representatives of the U. S. Bureau of Fisheries, which had entered into cooperation with the U. S. Bureau of Entomology, and the observations from Mound here recorded were made in the vicinity of the field laboratory of the latter bureau.

[4] Frequencies here mentioned were obtained by dividing the number of *humilis* caught in hauls of a seine of certain mesh and length over given areas by the number of collections so made.

[5] Frequencies here mentioned are the ratios of frequency of occurrence.

coming from upland glacial lakes. The white crappie (*Pomoxis annularis*) and the green sunfish (*Lepomis cyanellus*) are most frequent associates of this fish in Illinois waters. "If one may judge from its feeding structures, it is protected from serious competition with these companion species by differences in its food."

SEXES.

The sexes of *Lepomis humilis* are easily distinguishable immediately prior to and during the breeding season. The male with flowing milt is very brilliantly colored. The body color is opalescent green, shading into a greenish blue toward the dorsal fin. This bluish green background is scattered with eight indefinite bands of brilliant orange spots, extending from the dorsal fin ventrad to the region halfway between the lateral line and the belly. In some males there is an appearance of mottling with orange. The opalescent green is particularly brilliant between the eye and the maxillary and just posterior to the opercular spot, which is black, outlined with a narrow border of grayish white. The opercle is crossed horizontally by four bright golden bars. The top of the head is dark metallic green. There is a small black spot above the eye. The maxillary and mandible are dusky blue. The walls of the belly of the ripe male are light orange, blending ventrad into white. The dorsal fin is transparent, outlined with orange-red. The anal fin is similar but is brighter, and its anterior and ventral edges are lined with black. The ventral fins are salmon pink, with their lateral edges dusky. The pectoral fins are very light orange and transparent. The caudal fin is transparent, mottled with two rows of orange spots.

The ripe female with abdominal walls heavily swollen with mature eggs is not nearly as brilliantly colored as her mate. The body color is olivaceous green; the spots are not distinctly orange, being rather more dusky. The color effect is one rather of mottling than of banding; the mottled effect is noticeably prominent on the opercle. The opalescent green color characteristic of the breeding male is found in the female only between the eye and the mandible and on the opercle. The black spot over the eye of the male is not prominent in the female. The opercular spot is dusky in the female and the border of white not nearly so contrasted as in the male. The pectoral, anal, and ventral fins of the female are transparent and colorless. The caudal and dorsal fins are mottled faintly with dusky, the latter having a perceptible row of dusky spots or a dusky band. The anal fin is more noticeable ventrad and cephalad because of a dark outline.

When preserved in formalin, it is not difficult to identify the sexes, through the difference in reaction of the orange and dusky spots of male and female fishes, respectively. The spots on the male become very pale; those of the female, brownish black. Moreover, the difference in "appearance in outline as well as in color" (Forbes and Richardson, 1908) makes it possible to determine the sexes, "the males having the forehead concave, the profile steeper, and the ventrals longer."

The immature fish of either sex of this species is of marked difference in color and in color pattern from its parents. Its body

color is light olivaceous, with eight or nine dusky orange vertical bars extending from the dorsal to the ventral line. The barring becomes evident when the fish is 1.4 cm. long. The mottled and spotted effect appears when the fish measures about 4 cm. All the fins of the immature fish are of a green cast, at first sight colorless and transparent. The opercle is a brighter metallic green with one of the vertical orange bands extending across it. The eye of the immature fish is large.

BREEDING SEASON.

The breeding season of *Lepomis humilis* is an extended one, beginning early in spring and not ending until at least the first week in August for Iowa fish and lasting for Louisiana fish until the first week in September. The mating season begins in Louisiana ordinarily about the first week in April. In Iowa it begins at least six weeks later, occurring usually about May 20. Well-developed fry of at least 2 weeks of age have been taken as early as April 25 in Louisiana. Exceptionally cold weather may delay the first spawning several days, particularly since there appears to be a critical temperature at which egg laying occurs. This has not been accurately studied by observation, but by water temperature (Table 1) and breeding records for both Iowa and Louisiana it may be concluded fairly to be approximately 65° F. (Fig. 1). It is of interest to note that the pigmy sunfish *Elassoma zonatum*, of much smaller size and an inhabitant of a distinctly different environmental association, breeds at least a week earlier than *humilis* (Barney and Anson, 1920). The critical breeding temperature, however, for the two species is about the same, the earlier Elassoma mating occurring in shallower and clearer water, these conditions allowing for an earlier warming of the water.

TABLE 1.—*Average mean temperature of water at Mound, La., and Fairport, Iowa.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Mound, La.	48.5	53.0	60.0	75.0	80.0	82.5	85.0	83.5	80.0	74.0	64.0	50.0
Fairport, Iowa	33.0	33.0	49.0	51.5	63.9	76.1	84.5	75.7	71.7	54.4	41.3	36.1

It is not to be understood that the breeding season for a single fish, either male or female, may last through the entire spring and summer. The period of egg laying for an individual fish probably does not extend through more than a few hours of a single day. The extension of the laying season is caused by the attainment of sexual maturity by the younger fish that have not spawned previously during the spring or summer. The later limit of the breeding season of *Lepomis humilis* is based on records of two small females taken at Mound—one carrying 50 and the other 80 ripe or nearly mature ova—on August 29. Many males taken on the same day were flowing with milt. The latest record of a gravid female at Fairport is in a collection of August 3. This fish carried 175 eggs that appeared to be mature. A number of males taken in the same collection were ripe.

Other records of breeding for this fish are made by Forbes and Richardson (1908). They note that ripe males and females were taken in Meredosia Bay by Doctor Kofoid on June 8, 1899. Richardson (1913) records a male and female of this species in breeding color on May 23, 1911, in Quiver Marshes, Ill., over a freshly excavated nest in water 18 inches deep. He further notes that "rather late spawning was indicated in 1910 by the taking, July 7, at the head of Liverpool Lake, of males in full color and females heavy with eggs."

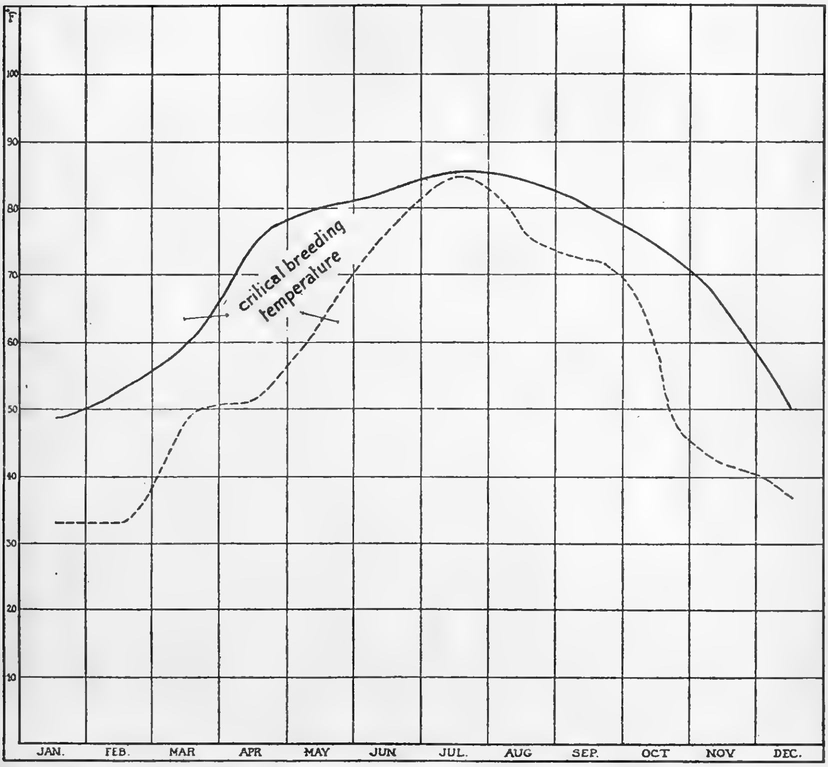

FIG. 1.—Critical breeding temperature and growing season of *Lepomis humilis* in Louisiana and Iowa as indicated by monthly average mean water temperatures. ——— Louisiana; ------ Iowa. It is probable that active feeding and growth begin when the water temperature reaches the vicinity of 55° F. and continue until the temperature returns to that point in the fall. The growing season of the species is therefore at least 3 months longer in Louisiana than in Iowa.

THE NEST AND SPAWNING HABITS.

The nest of *Lepomis humilis* is similar to those of other sunfishes but, as might be expected, somewhat smaller. It has been observed to be excavated by the male fish, which, by powerful pushing of the head and by flirts of the tail, combined with active trembling of the fins, removes the smaller pebbles and lighter sand from a bowl-shaped pocket. The nest is circular or nearly so, measuring from 15 to 18 cm. in diameter. The depth of the nest itself varies from 3 to 4 cm. An unavoidable lowering of the water stage of the Fairport sta-

tion reservoir on May 30, 1921, laid bare a large number of nests of *humilis* (Fig. 2). The nests were on a gradually sloping bank on each side of the intake of the reservoir. The bank measures 365 feet in length, and on its usually submerged slope 960 lately excavated nests were counted. The banks of the reservoir had been left in their natural condition after their construction. The soil was scattered with stones from the excavated soil and with flaked and cracked limestone, wastage of the material used in construction of the cement intake block. Over this gravelly bottom there had been deposited a 3 or 4 inch layer of mud and silt sedimented from the pumpage from the river. The fish had shaped their nests in this mud, excavating until they struck a solid bottom of gravel (Fig. 3). On the steeper opposite bank where the angle of the slope was too abrupt for the deposition of silt an occasional nest was found where small piles of gravel made a sort of terrace in the rocky slope. In the delta country of northern Louisiana where there is no gravel on the bayou bottoms the fish probably lays its eggs in nests excavated from the mud. Most of the nests uncovered by the lowering of the water level of the reservoir were in a band extending around the more gradually sloping side of the pond. At the usual stage of water these nests would be covered with 12½ inches of water. The lowermost nests were in water which, at the usual stage of the reservoir, would measure 2 feet and 9 inches deep. It may be, however, that these nests were made at this depth because of lack of suitable bottom or because of crowding. The level of the reservoir varies daily about 9 inches, however, and there is the possibility that these nests were made during the periods of very low stage.

The male in his brilliant coloration lures the breeding female onto the nests, where the mature ova are expelled. Fertilization takes place immediately. The two fish after much maneuvering and occasional splashing come to a position with the bellies touching each other, whereupon the eggs and sperm are delivered. Gill (1905), discussing the breeding habits of the sunfish *Eupomotis gibbosus*, has found this activity to characterize that species. He further quotes Reighard: "A female if undisturbed takes about an hour to lay her eggs, though she may frequently during this time leave the nest and return to it again." Further discussing mating habits, he quotes Reighard as having noted "a case in which an individual male of *Eupomotis gibbosus* reared in one nest two broods laid at quite different times by two females." This latter observation probably holds true for *humilis*, for immediately after the eggs are laid the mother *humilis* leaves the nest and does not appear again with her mate. Reighard believes the relation between the sexes of *Eupomotis gibbosus* is one of "promiscuous polygamy." This appears to be the relation in the orange-spotted sunfish also.

The male *humilis*, similar to *gibbosus*, remains on the nest until the young are hatched. The *humilis* eggs, measuring 1 mm. in diameter, are slightly adhesive and cling to the upper surfaces of the stones and pebbles in the nest bottom, where they are continually fanned by the quivering fins of the male to prevent their burial in silt. The male fish occasionally leaves the nest to fight off other males intruding for the purpose of feeding on the developing embryos. Darters are common enemies. Spot-tailed minnows (*Notropis hudsonius*)

FIG. 2.—View of part of gradually sloping reservoir bank, U. S. Fisheries Biological Station, Fairport, Iowa, after water was lowered on May 30, 1921. Many nests of *Lepomis humilis* were laid bare.

FIG. 3.—Close-up view of nests of *Lepomis humilis* (shown in Fig. 2) excavated from soft mud to a gravel bottom on which the eggs are laid. Nests measured from 12 to 15 cm. in diameter and from 3 to 4 cm. in depth.

have been observed raiding the nests of *humilis*, particularly when the males of the latter species were engaged in fighting off their own kind.

The period of incubation for the eggs of the orange-spotted sunfish has been observed to be five days, with the water varying in temperature between 65 and 70° F. The newly hatched fry measures 1 cm. in length. The number of eggs laid each season varies directly with size and age of the female. The maximum number of eggs found in any of the females collected from the Fairport reservoir is 4,700. This count was for a fish 10.5 cm. long (about 4 inches), taken in early June. The smallest fish found carrying ripe ova was 3 cm. long (about $1\frac{1}{5}$ inches). It was taken August 3 at Fairport and carried 175 eggs. The following table (2) indicates the increasing fecundity of the species as the size of the female increases.

TABLE 2.—*Ova counts of Lepomis humilis of different lengths collected in Iowa and Louisiana from April through August.*

Cm.	Ova.	Cm.	Ova.	Cm.	Ova.	Cm.	Ova.	Cm.	Ova.	Cm.	Ova.	Cm.	Ova.	Cm.	Ova.
3.0	175	4.0	......	5.0	300	6.0	......	7.0	.....	8.0	520	9.0	1,340	10.0	4,600
3.1	......	4.1	225	5.1	1,828	6.1	......	7.1	.....	8.1	2,280	9.1	......	10.1	......
3.2	......	4.2	200	5.2	1,152	6.2	......	7.2	.....	8.2	2,160	9.2	3,680	10.2	......
3.3	......	4.3	530	5.3	......	6.3	......	7.3	.....	8.3	1,440	9.3	......	10.3	4,700
3.4	50	4.4	168	5.4	......	6.4	2,110	7.4	.....	8.4	......	9.4	1,340	10.4	......
3.5	416	4.5	310	5.5	......	6.5	2,680	7.5	.....	8.5	......	9.5	......	10.5	4,700
3.6	415	4.6	620	5.6	......	6.6	2,460	7.6	.....	8.6	......	9.6	......	10.6	......
3.7	......	4.7	752	5.7	1,620	6.7	......	7.7	.....	8.7	2,260	9.7	......	10.7	......
3.8	......	4.8	576	5.8	......	6.8	......	7.8	.....	8.8	3,000	9.8	......	10.8	......
3.9	......	4.9	576	5.9	......	6.9	......	7.9	.....	8.9	......	9.9	......	10.9	......

GROWTH AND ATTAINMENT OF SEXUAL MATURITY.

The rate of growth of the orange-spotted sunfish, as indicated by scale examinations, differs considerably in representatives of this species from Louisiana and Iowa. The earlier breeding season and the longer feeding and growing period in Louisiana (Table 1 and Fig. 1) make the southern fish somewhat larger than an Iowa specimen of the same age. The annuli of the scales of *Lepomis humilis* are very satisfactory indicators of age. The annuli, particularly of northern fish, stand out very plainly. The information at hand on the growth of the sunfish has been obtained through a study of the scales of 180 examples from Louisiana captured in each month from March to November, inclusive, and of 389 individuals taken in Iowa during a similar period. Although no observations are available on the actual growth of a single specimen over an extended period of time, a more accurate knowledge of the average growth of the species has been obtained by the study of the scales. The fish considered in this connection were measured and determinations were made of sex and of ripeness, judged particularly in the females by the condition of the contents of the ovaries. A number of scales of each fish taken from a point just posterior to the insertion of the pectoral fin were examined to ascertain the growth season of the specimens.

Table 3 gives the number of fish of various ages examined and their average mean lengths by months. Both Louisiana and Iowa collections are included.

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TABLE 3.—*Growth records of Lepomis humilis from Iowa and Louisiana.*[1]

Month.	Growth years.															
	First.				Second.				Third.				Fourth.		Fifth.	
	Iowa.		Louisiana.		Iowa.		Louisiana.		Iowa.		Louisiana.		Iowa.		Iowa.	
	Number.	Average length.	Number.	Average length.	Number.	Average length.	Number.	Average length.	Number.	Average length.	Number.	Average length.	Number.	Average length.	Number.	Average length.
		Cm.		Cm.		Cm.		Cm.		Cm.		Cm.		Cm.		Cm.
March					29	2.7			13	4.0			1	4.9		
April					37	2.5			17	3.95			2	5.4		
May					6	3.05			5	4.65	1	5.1	4	5.25		
June			26	1.8	5	4.1			35	5.35			5	7.4	9	9.3
July	4	2.1	22	1.95	16	3.25			6	4.85			3	5.3	1	5.6
August	97	1.85	75	2.3	13	4.2	12	3.55	17	5.5						
September	3	2.35	32	2.6	7	3.35			6	4.55			3	5.85		
October					7	4.5			21	5.25			11	6.4		
November			8	3.45			4	4.55								

[1] The cause of the apparently undue fluctuations in average lengths over a given growth year is attributable to the method of computation and to the accidental occurrence of a number of especially well grown or poorly grown fish in the collections of certain months.

Figure 4 indicates the growths of the sunfish under the different climatic conditions of Louisiana and Iowa. The figure also points out the periods of ripeness of fishes of different seasonal birth. It may be noted that the growth of the sunfish over four years of its life is not especially slowed down, even though the fish reached sexual maturity in the second year. The usual circumstance—that the attainment of sexual maturity is accompanied by a considerable retardation of growth—is not strikingly borne out in the average curve of growth of this species (Fig. 4). A breeding female 3 cm. long may triple her size within four years. The curve of growth (Fig. 4), rising at an angle of 40° or more and sustaining its direction quite into the fourth year, indicates the ability of the fish to obtain and utilize in growth an increased food supply even after the attainment of adulthood, determined by sexual activity. The growth of this sunfish stands in contrast to that of the smallest representative of the family Elassoma, whose growth (Barney and Anson, 1920) after reaching sexual maturity at the end of the first year of its life is very markedly slowed down. It is not to be understood, however, that the ripening of the sexual organs of *humilis* occurs without expense to growth. The curve of growth (Fig. 4) is based on averages obtained from the measurements of large numbers of fish of both sexes. The facts that the breeding season is not a limited one and that spawning fish may be taken in any summer month along with large numbers of spawned or ripening fish have a tendency to smooth out the growth curve. Irregularities of growth of individual fishes or sexes are masked, because of the length of the breeding season and the varying time of attainment of sexual maturity and because of the process of computation used to secure the points on which the growth curve is founded. The difference between the growth of Elassoma and that of *humilis* is that the retardation of growth of Elassoma after sexual maturity is permanent and increase in size of this species thereafter is at a very slow rate, whereas in *humilis* the retardation

of growth during the ripening of the sexual products is merely temporary, and increase in size of this species occurs at a rapid rate directly following spawning.

The orange-spotted sunfish hatched from early laid eggs may lay its first eggs late in the second growth year in August. Its size, however, at the egg-laying period may be somewhat smaller than the average mean length of fishes of its age, due probably to the fact that the growth of the sexual organs to ripeness has prevented to an appreciable extent the increase in length and weight that the fish would otherwise have had.

In this connection it may be mentioned that the ovaries of a ripe female 6.4 cm. in length in the third year of its growth, captured June 18, 1921, weighed 0.6 g., or approximately one-tenth of the total weight of the fish, 6.1 g. This observation may indicate the demand the sexual development makes on the growth of the fish. Further in this connection a scale of a breeding female fish in its second growth year, 3.4 cm. in length, taken at Fairport on August 3 (Fig. 5), showed an especially large growth the first year but a small one during the current growing season. The reduced growth of the second growth year of the fish suggests that the sexual development of the animal had been compensation for it. So again, two ripe females 3 and 3.4 cm. long, respectively, taken at Mound on August 29, support this opinion. They both showed in their scale examination ample growth for the first growing year, but the second or current year's growth, as indicated by the increase in size of the scale since the first annulus, was small. The fact that these youngest breeding fishes were not encountered till the August collections of either Louisiana or Iowa, even though many fishes in the second growth year were examined from collections made in June and July, further bears out the point that the breeding activity does not de-

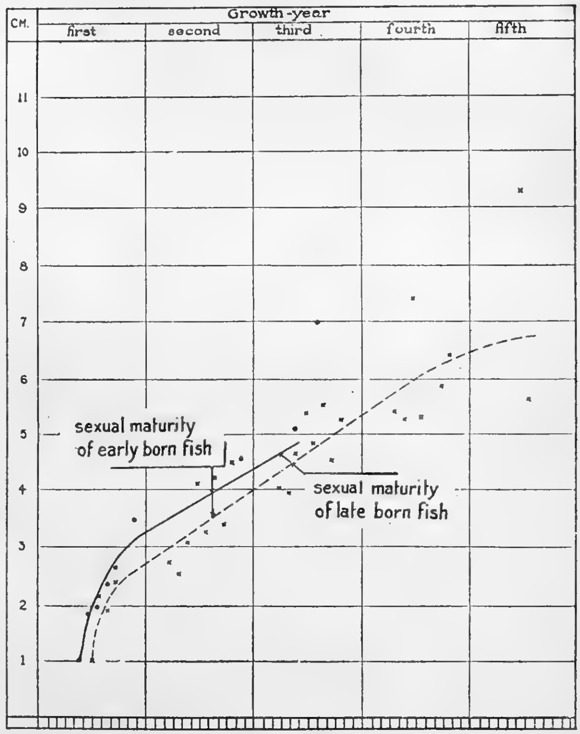

FIG. 4.—Growth of *Lepomis humilis* as determined by scale examinations. ———, curve of growth of Louisiana fish; ------, curve of growth of Iowa fish. *x*, average length for given months, Iowa fish; *o*, average length for given months, Louisiana fish. The points *x* and *o* represent average lengths as indicated in Table 3.

pend so much on size or season as it does on actual age measured in terms of favorably temperatured days for feeding and growth. This is substantiated by the fact that the large majority of fish beginning their third growth year, though in actual calendar days not 2 years old, are spawning fish in the May of that growth year. The presence of the relatively few late breeders of the second growth year probably tends toward a lengthening of the breeding season in the third and fourth growth years, though this question has not been verified by observation on a given second-growth-year breeder. It is known, however, that all the breeding sunfish for a given year do not become ripe at the same time in early spring.

Data supplementing this observation of extended breeding period are at hand in the form of the following frequency records of *Lepomis humilis* collected from May to December, 1918, at Mound, La.:

	Relative frequency.		Relative frequency.
May 9	0.1	August 15	7.9
May 25	.09	August 20	22.5
June 8	13.9	September 12	23.4
June 20	12.6	September 26	13.8
July 5	3.4	November 15	26.2
July 18	.7	December 7	20.1
August 5	4.0		

The appreciable increase in relative frequency of the species, as indicated for collections in June, is, without doubt, due to the early spring production resultant from the spawning of fish in the third or later growth years. The large production indicated as occurring in August (the increased frequency being noted for late August and for the remainder of the year[6]) is resultant from the spawning of 2-year-old fish and of others of greater age whose breeding period is late in summer. The marked decrease in relative frequency noted during July and early August is due, there seems little doubt, to the utilization of *humilis* as food by larger carnivorous fish during the usual period of low-water stage with resultant concentration of fish and loss of protective shallows.

Lepomis humilis reaches a length of at least 11.2 cm. (about 4½ inches) and an age of 7 years, probably more. The large number of circuli representing the annual growths of the fifth, sixth, and seventh years and their very large size quite obliterate the earlier annuli and make it impossible to accurately determine the age of a full-grown sunfish of this species. However, in *Eupomotis gibbosus*, the age of an adult 11.2 cm. or more in length may be quite easily determined. The difference lies probably in the faster early growth of *gibbosus*.

FOOD.

Information regarding the food of *Lepomis humilis* is available through the records of stomach examinations of examples of this species collected at Mound, La., on the occasion of the study of the effectiveness of Gambusia and other small fishes as mosquito-control agents. The records here tabulated (Table 4) are given by averaged estimated percentages of the food organisms ingested. It is

[6] Collections were made by using ¼-inch mesh seine, which allowed all *humilis* under an inch long to pass through. This is the reason for the increased frequency coming about a month after the spawning, as in the spring.

FIG. 5.—Scale of ripe female *Lepomis humilis*, 3.4 cm. long, taken August 3, 1921, from reservoir of U. S. Fisheries Biological Station, Fairport, Iowa. Very large first-year growth is indicated by position of single annulus *a*. Smaller second-year growth is due doubtless to increased nutritional requirements of developing sexual organs. Scale indicates that the fish from which it came was born early in the breeding season. × 25.

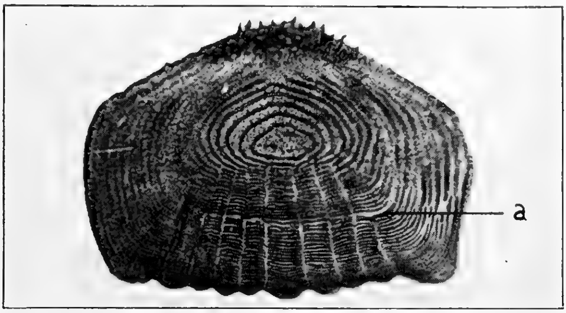

FIG. 6.—Scale of female *Lepomis humilis*, 3.6 cm. long, which had carried no ripe or ripening eggs. Fish taken September 6, 1921, from reservoir of U. S. Fisheries Biological Station, Fairport, Iowa. The fish would have spawned in the next spring at the beginning of the third growth year. Relatively small amount of first-year growth and the larger second-year growth, suggested by the position of the annulus *a*, indicate that the fish from which the scale was taken was born rather late in the spawning season. × 25.

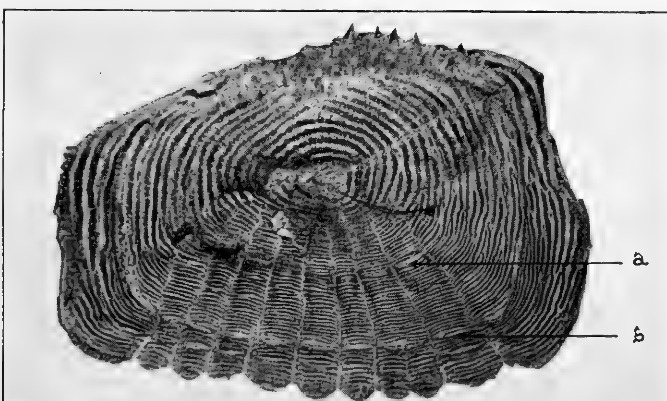

FIG. 7.—Scale of ripe female *Lepomis humilis*, 4.0 cm. long, taken June 8, 1921, from reservoir of U. S. Fisheries Biological Station, Fairport, Iowa. The fish from which the scale was taken was in its third year of growth as suggested by the annuli *a* and *b*, and had not spawned previously. The fish was probably born rather late in the spawning season. This scale, taken in the third year of growth, is correlated with that shown in Figure 6, taken in September of the second growth year. × 25.

noted that the orange-spotted sunfish feeds primarily on crustaceans and insect larvæ but that it occasionally eats a small fish and probably accidentally ingests some algæ. From the Fairport reservoir a small *humilis* 7.5 cm. long has been taken in December, in which were found two small individuals of its own species.

TABLE 4.—*Food of 57 Lepomis humilis and 77 Gambusia affinis compared—Fish collected at Mound, La.*

[Figures indicate estimated per cent.]

Food organisms.	Lepomis humilis.	Gambusia affinis.
Crustaceans:	*Per cent.*	*Per cent.*
Cladocera	15.36	(1)
Copepoda	9.80	
Ostracoda	1.48	
Unrecognizable	6.89	
Total	33.53	32.00
Insect larvæ:		
Chironomidæ	44.09	(1)
Corisidæ	1.78	
Neuroptera	2.57	
Unrecognizable	2.37	
Total	50.81	2.8
Rotifers, etc	1.07	
Fishes	1.40	
Plants	2.28	60.00
Unrecognizable débris	10.91	0

1 Predominant.

A fish living on large numbers of minute crustaceans and insect larvæ is of particular value in the annual turnover of these microscopic animals into flesh that may in turn serve the food requirements of larger predacious fish. The value of *humilis* in this particular field is pointed out on page 12.

Another consideration of interest with respect to the possible usefulness of the fish comes to light when the records of the contents of the stomachs of the Louisiana sunfish are compared with those of the recognized mosquito-control agents (*Gambusia affinis*) caught in the same region and environments and at the same time. The comparison of the figures representing percentages of the different organisms found shows that the sunfish and top minnow eat about the same percentage of crustaceans, Cladocera being predominant in both fishes' diet. The sunfish record of insect larvæ ingested gives 50.81 per cent against 2.8 for Gambusia. It is of particular significance to note here again that in both fishes Chironomidæ were the most numerous of the insect class, although the sunfish surpassed the minnow by about 20 times in the frequency of its feeding on immature Diptera. Finally, it is significant that while *humilis* contained 2.28 per cent of vegetable food Gambusia contained 60 per cent. It is probable that the plants of the *humilis* diet are accidentally taken, but the top minnow makes some choice of algal food. In view of the fact that the food habits of the orange-spotted sunfish are so similar to those of Gambusia, especially with regard to the crustacean and insect larval consumption, and also because the immature insect ingestion of *humilis* is 20 times as frequent as in Gambusia and the

plant ingestion some 20 times less frequent, it appears reasonable to believe that the orange-spotted sunfish, which is small and prolific, is a very considerable agent for mosquito control wherever and whenever mosquito-egg deposition occurs in its environment; and this is, by our observation, a common occurrence. The sunfish may not be as effective as Gambusia, however, even though its diet would appear more favorable, since the latter's very small size and surface-feeding habit make it a serious enemy of the surface-living mosquito larvæ.

VALUE OF THE ORANGE-SPOTTED SUNFISH.

Lepomis humilis, because of its small size, even when fully grown, has little or no value as a sport or food fish, though when it reaches a 3 or 4 inch length it takes the hook readily. Its value in the field of food and sport lies indirectly in its utilization as food by those carnivorous fishes that are especially valued by the angler and epicure. That the fish has a genuine significance in this connection has been proven in the culture of the large-mouth black bass in the experimental ponds at Fairport, Iowa.

Accurate data regarding the usefulness of *humilis* as a forage fish have been obtained. In 1917 in the Fairport Pond D 3, area 0.846 acre, there were liberated in early spring 51 adult black bass and 1,238 adult and 990 young *Lepomis humilis* of one growth year. In October of the same year there were obtained from the pond 9,234 3 to 5 inch bass fingerlings (rate of 10,915 per acre) and only 626 adult *humilis*. Johnson and Stapleton (1921), experienced practical fish-culturists, have made the statement that "a 2-acre pond producing 10,000 1-year-old black bass from 4 to 6 inches long would be a remarkably successful enterprise." The fact that no orange-spotted sunfish of the current year's production survived the season (Table 5) indicates that the bass were making use of them as food. The parental protection given the bass eggs prevented any depredations by the sunfish as eggeaters, and the later rapid growth of the bass fry carried them quickly out of the realm of possible attack and made them at an early age the enemies of the sunfish.

TABLE 5.—*The orange-spotted sunfish in large-mouth black-bass culture.*

Species.	Spring plant.			Fall invoice.		
	Age.	Number.	Weight.	Age.	Number.	Weight.
			Lbs.			*Lbs. oz.*
Black bass	Adult	51		Adult	[1] 51	
Do.	Young			3-5 inch fingerlings.	9,234	32 4
Orange-spotted sunfish	Adult	1,238	8	Adult	626	
Do.	Young	990		Young	0	

[1] Seventeen of these removed during the summer.

Not alone does the sunfish possess value because it serves as fish food. The important factor of its utility lies rather in that it is the prime agent in the economy of a bass pond, for the sunfish transforms into its flesh many of the minute water fleas and insects that

would otherwise remain unused in the pond. The sunfish earns its importance in pond cultivation by its feeding habits and because of its small size and early and noteworthy prolificness.

To indicate the ease with which *humilis* may be raised, the production of a Fairport pond used in buffalo-fish cultivation is recorded. Early in the spring of 1921 seven medium-sized buffalo fish were placed in a pond measuring 0.846 acre for the purpose of noting the effect of certain artificial factors on the pond production of the buffalo fish. The pond intake was protected by wire screening of three-fourths inch mesh placed at the outlet of the reservoir. The pond water supply was obtained from this reservoir, in which there was a large number of orange-spotted sunfish of all ages. In October inventory was taken of the fish of the pond. There were obtained 98,200 2 to 5 inch buffalo fish and at least 50,000 *humilis* of the first growth year—an inch or more in length—that had been introduced into the pond by passing through the screened intake and had made normal growth during the summer. The buffalo-fish production here referred to was by far the maximum pond production for this species so far recorded, but it is the more important when it is appreciated that the pond simultaneously supported such a large number of sunfish. It is of interest to note at this point a statement of Johnson and Stapleton (1921) that 20,000 yearling sunfish ($1\frac{1}{2}$ to 2 inches) to an acre of water would be a noteworthy production.

From the 960 *humilis* nests counted in the Fairport reservoir in May, 1921, it seems probable, in view of the number of eggs laid by females as indicated in Table 2, that the production of the reservoir, measured in total number of *Lepomis humilis* hatched, was not less than 500,000 fish, and this naturally, with no care from the personnel of the station.

This production of *Lepomis humilis* and the information at hand regarding the growth, early sexual maturity, and usefulness of the species in bass ponds suggest the possible service that a small nursery pond containing *humilis* alone would render a fish farm or private bass-fishing lake. If properly stocked, the nursery pond would always contain an ample number of small sunfish to serve as food at desired intervals for a large number of black bass. Such an arrangement would forthwith increase the capacity of a large lake to support the bass

The orange-spotted sunfish, because of its small size, is a valuable test animal for biochemical investigations where fish may be suitably used. An example of the usefulness of this species in this field is suggested by Shelford (1917) in his report dealing with the effect on fishes of pollution by diluted chemical wastes.

The species also has an interesting relationship in the natural history of fresh-water mussels. This sunfish may be the host of the mussel *Anodonta corpulenta* (Coker et al., 1921) and perhaps of other noncommercial mollusks. A natural infection of *Lepomis humilis* with the glochidia of the valuable yellow sand-shell (*Lampsilis anodontoides*) is reported, but this is of doubtful significance, as the species has never been carried through its metamorphosis experimentally other than on the gars. *Lepomis humilis* is the only member of the Centrarchidæ that has given uniformly immune reactions to infections with glochidia of the mucket shell *Lampsilis luteola* (Anson and Howard, MSS.). All other species of this family

so far tested have reacted favorably to infection and are being used in the artificial propagation of this mussel.

The food, size, habits, and habitat of *Lepomis humilis* in Louisiana suggest that the species may be of considerable importance as a natural enemy of immature mosquitoes.

SUMMARY.

Lepomis humilis, the orange-spotted sunfish, has a natural distribution throughout the Mississippi drainage. It is found particularly in lowland waters and has been studied in typical habitats in Iowa and Louisiana. Its usual environmental associates are especially the white crappie, the green sunfish, and the golden shiner. In Louisiana Gambusia is usually found in abundance with the sunfish. The sexes of the orange-spotted sunfish are easily determined during the breeding season by the color, color pattern, and differences in outline. The male at this season is very brilliantly colored; the female is much duller.

The breeding season varies in length for fish of Iowa and Louisiana. The period of mating is a protracted one, lasting for Louisiana fish nearly 5 months and for those of Iowa about 10 weeks. The breeding season is prolonged, especially through the attainment of sexual maturity by certain fish in their second growth year. Growth of Louisiana fish indicated by scale examinations is somewhat faster than that of Iowa fish. Early born fish may attain sexual maturity late in their second growth year. The great majority of orange-spotted sunfish lay their first eggs at the beginning of the third year. There is a normal retardation of growth as the sunfish reaches sexual maturity. The growth of the species, however, continues at a rapid rate through the third and fourth growth years. *Lepomis humilis* reaches a length of about 4 inches.

The nest of *Lepomis humilis* observed in Iowa is a small bowl-shaped excavation made in gravel in from 12 to 36 inches of water. Its habitat where observed in the delta country of Louisiana furnishes no gravel for nest building and eggs are probably laid on the mud. Mating is promiscuous, and the eggs are protected from spawn-eating fishes by the pugnacious male, which remains on the nest fanning the eggs with its fins until the fry emerge. The number of eggs laid by each female varies with its size and age. The maximum number of eggs observed was 4,700 for a female 10.5 cm. long, taken in June; the smallest egg-bearing female measured 3 cm.

The food of *Lepomis humilis* is made up primarily of crustaceans and insect larvæ. In these items the diet of the sunfish closely resembles that of the recognized mosquito-larvæ destroyer, Gambusia.

The value of the orange-spotted sunfish lies in its importance in the economy of the fishpond. It transforms the microscopic fauna into its own flesh, which in turn may serve as the food of larger carnivorous fishes of acknowledged sport and food value. Data are presented indicating the usefulness of this sunfish in the artificial pond culture of the large-mouth black bass. Other data presented suggest the prolificness of the fish.

The value of *Lepomis humilis* as a test fish in pollution and other similar studies, in the biology of the fresh-water mussel, and in possible usefulness as a mosquito-control agent is discussed.

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O

TRADE IN FRESH AND FROZEN FISHERY PRODUCTS AND RELATED MARKETING CONSIDERATIONS IN BOSTON, MASS.[1]

By L. T. Hopkinson, *formerly agent, U. S. Bureau of Fisheries.*

CONTENTS.

INTRODUCTION.

The Boston market survey is the sixth of a series of trade investigations made by the Bureau of Fisheries. The cities previously canvassed are Louisville, Ky., Pittsburgh, Pa., Chicago, Ill., Minneapolis and St. Paul, Minn., and Seattle, Wash.

PRODUCTION.

As a producing center Boston ranks first among American fishing ports, its vessel landings of fresh fish alone exceeding 100,000,000 pounds annually, a quantity surpassed only by that taken at Grimsby, England. The following table shows, by months and species, the quantity and value of fresh fish landed at Boston by fishing vessels during the year ended September 30, 1922.

Quantities and values of certain fishery products landed at Boston by American fishing vessels during the year ended September 30, 1922.

Month.	Cod.		Haddock.		Hake.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
1921.						
October	2,313,280	$109,547	5,558,390	$151,121	628,474	$11,208
November	1,480,481	61,287	4,115,385	157,565	522,881	7,600
December	1,260,542	63,845	4,253,995	231,334	295,969	8,803
1922.						
January	1,205,305	63,658	3,828,770	207,181	103,715	5,475
February	2,777,270	92,961	5,846,805	165,892	141,175	5,470
March	3,760,913	88,935	5,321,755	87,994	109,120	3,751
April	2,798,858	73,050	3,622,448	108,510	173,540	3,188
May	3,001,815	82,382	4,346,375	104,552	106,205	2,248
June	2,918,916	89,216	3,315,032	82,958	150,839	3,398
July	2,561,288	83,874	3,191,784	81,414	222,928	5,564
August	3,043,656	105,065	3,846,315	82,979	196,762	4,869
September	2,629,273	80,927	4,465,130	88,985	437,710	6,253
Total	29,751,597	994,747	51,712,184	1,550,485	3,089,318	67,827

[1] Appendix XVI to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 939

Quantities and values of certain fishery products landed at Boston by American fishing vessels during the year ended September 30, 1922—Continued.

Month.	Pollock.		Cusk.		Halibut.	
1921.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
October	454,942	$10,331	76,507	$1,172	599,728	$86,747
November	175,660	3,111	80,840	1,251	25,372	6,065
December	183,490	3,751	125,500	2,020	49,130	12,404
1922.						
January	94,909	4,012	113,155	2,750	38,692	8,889
February	93,949	4,044	132,445	2,653	188,834	32,115
March	99,111	3,450	163,438	1,889	483,722	76,255
April	154,218	3,962	157,295	1,805	486,342	57,171
May	217,054	5,778	97,445	1,102	479,871	64,920
June	228,378	5,535	33,520	562	395,476	56,843
July	374,874	7,605	35,407	538	614,356	68,277
August	417,858	9,546	57,905	726	549,087	67,383
September	407,925	7,677	45,790	673	404,696	59,709
Total	2,902,368	68,802	1,119,247	17,141	4,315,306	596,778

Month.	Mackerel.		Miscellaneous.		Total.	
1921.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
October	14,850	$2,769	316,668	$15,596	9,962,839	$388,491
November	343,700	51,733	240,305	12,675	6,984,624	301,287
December	4,995	1,149	231,505	14,906	6,405,126	338,212
1922.						
January	....	....	252,700	14,092	5,637,246	306,057
February	....	....	381,149	17,543	9,561,627	320,678
March	100	61	914,341	36,149	10,852,500	298,484
April	....	....	319,735	9,997	7,712,436	257,683
May	92,552	15,227	484,567	9,875	8,825,884	286,084
June	816,565	59,530	308,453	39,351	8,167,179	337,393
July	15,238	761	1,632,707	203,506	8,648,582	451,539
August	21,045	836	1,231,758	148,963	9,364,386	420,367
September	637,382	25,054	799,390	75,797	9,827,296	345,075
Total	1,946,427	157,120	7,113,278	598,450	101,949,725	4,051,350

MARKETING PROSPECTS.

It has been conservatively estimated by prominent men in the Boston fish trade that the vessel landings of ground fish at that port, now averaging approximately 7,000,000 pounds per month, could be doubled in the brief space of 90 days, provided the market for these fishes was sufficiently expanded to absorb this increase. With this situation in view it is evident that the important problem now confronting Boston fishing interests is that of extending the sale of cod and haddock, the two principal products of the ground fishery. The actual availability of a potential market of sufficient size to absorb such increased production is evidenced by the fact that the center of distribution for Boston fish (as revealed in Fig. 2 of this report, p. 15) lies about 750 miles northeast of the center of population of the United States shown in the United States Bureau of the Census population statistics for 1920.

DISTRIBUTION DURING SEPTEMBER, 1922.

Owing to the amount of research required for the determination of Boston's distribution of fresh and frozen fishery products, it was found necessary in conducting the present survey to confine the discussion of this subject to a period of one month. The month of

September, 1922, was therefore selected, it being considered the most representative average period for distribution during the current year. During this period there were 14,283,761 pounds of fresh and frozen fishery products received at Boston, consisting of 13,244,074 pounds of fish, 616,355 pounds of lobsters, 338,964 pounds of clams, 80,544 pounds or 10,068 gallons of oysters, and 3,824 pounds or 478 gallons of scallops. Of the quantity of fish received there were 11,056,709 pounds distributed fresh or frozen, 458,587 pounds salted, 391,788 pounds lost in shrinkage, 349,263 pounds smoked, 50,000 pounds canned, and 937,727 pounds frozen and held in storage, leaving a total distribution of all classes of fresh and frozen fishery products amounting to 12,096,396 pounds. Of this amount 99 per cent was distributed to points in the United States and 1 per cent to points in Canada.

Distribution in the United States was largely confined to Massachusetts and the neighboring States of Connecticut, New York, Pennsylvania, and Rhode Island, this group receiving 89 per cent of the total quantity distributed in the United States. Out of the total quantity distributed from Boston during September 56 per cent was consumed within the State of Massachusetts.

Summary, by States and Canada—listed according to amount received—of fresh and frozen fishery products distributed through Boston, Mass., during September, 1922.

Locality.	Fresh and frozen fish.	Lobsters.	Clams.	Oysters.	Scallops.	Total.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
Massachusetts	6,023,525	384,177	279,456	61,080	3,088	6,751,326	56
New York	2,257,697	80,629	6,867	1,536	240	2,346,969	19
Pennsylvania	560,551	53,023	4,560	448		618,582	5
Rhode Island	585,002		133	64		585,199	5
Connecticut	400,961	16,978	30,104	648		448,691	4
New Hampshire	274,258	3,556	4,438	5,608		288,060	2
Illinois	148,258	21,326	1,750			171,334	1
Maryland	144,323	6,557			24	150,904	1
Canada	132,443		1,024	912		134,369	1
Maine	117,479	86	1,961	7,200	8	126,734	1
Vermont	106,979	2,103	4,596	2,680		116,358	
Ohio	80,379	11,239	1,475	240	272	93,605	
Michigan	54,642	3,186	1,115			58,943	
New Jersey	44,853	11,153		80		56,086	
District of Columbia	47,732	5,175	60			52,967	
Wisconsin	19,124	2,965				22,089	
Missouri	18,038	2,255	595			20,888	
Delaware	12,955	590	250			13,795	
Minnesota	3,439	4,086			80	7,605	
West Virginia	5,463	793				6,256	
Nebraska	3,233	1,687	580			5,500	
Virginia	4,923	232				5,155	
Colorado	2,918	1,761			64	4,743	
North Carolina	3,228	203				3,431	
Indiana	1,748	700			16	2,464	
Louisiana	895					895	
Kentucky		807				807	
Tennessee	545	260				805	
Iowa	613	72				685	
South Carolina	365					365	
Utah		250			32	282	
California		200				200	
Florida	150					150	
Georgia		126				126	
Alabama		90				90	
Oklahoma		90				90	
North Dakota				48		48	
Total	11,056,709	616,355	338,964	80,544	3,824	12,096,396	

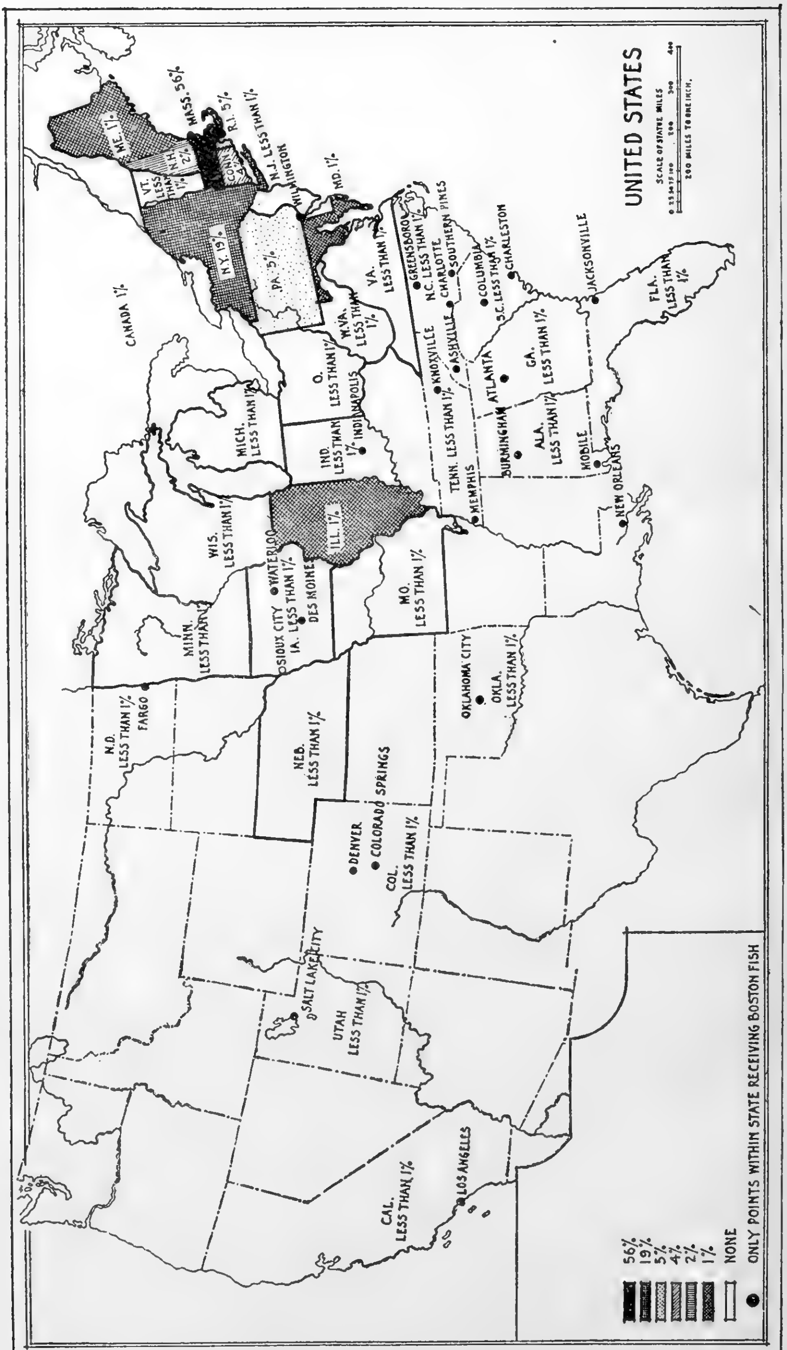

FIG. 1.—Distribution of fresh and frozen fishery products from Boston, Mass., during September, 1922.

Fresh and frozen fishery products distributed through Boston, Mass., during September, 1922.

FRESH AND FROZEN FISH.

Destination.	Pounds.
CANADA.	
Montreal	128,917
Hamilton, Quebec, Winnipeg, Toronto, and all other points	3,516
UNITED STATES.	
Colorado:	
Colorado Springs	105
Denver	2,813
Connecticut:	
Hartford	44,452
Meriden	13,283
New Britain	14,803
New Haven	58,029
Stamford	11,418
Waterbury	19,891
All other points	239,085
Delaware: Wilmington	12,955
Florida: Jacksonville	150
Illinois:	
Chicago	134,957
All other points	13,301
Indiana:	
Indianapolis	878
All other points	870
Iowa:	
Des Moines	263
Sioux City	30
Waterloo	320
Louisiana: New Orleans	895
Maine:	
Bangor	28,798
All other points	88,681
Maryland:	
Baltimore	142,802
All other points	1,521
Massachusetts: All points	6,023,525
Michigan:	
Detroit	51,230
All other points	3,412
Minnesota:	
Minneapolis and St. Paul	1,944
All other points	1,495
Missouri:	
Kansas City	5,178
All other points	12,860
Nebraska: Omaha	3,233
New Hampshire:	
Manchester	46,249
All other points	228,009
New Jersey:	
Jersey City	450
Newark	1,111
Trenton	16,476
All other points	26,816
New York:	
Albany	77,904
UNITED STATES—continued.	
New York—Continued.	
Amsterdam	12,040
Auburn	6,323
Binghampton	9,006
Buffalo	47,256
Elmira	2,382
Jamestown	229
New Rochelle	3,668
New York City	1,720,874
Rochester	87,952
Schenectady	10,628
Syracuse	37,362
Troy	6,602
Utica	28,015
Watertown	2,895
All other points	204,561
North Carolina:	
Asheville	2,980
Charlotte	200
Southern Pines	48
Ohio:	
Cincinnati	3,229
Cleveland	52,168
Columbus	3,496
Dayton	1,012
Toledo	1,537
Youngstown	4,195
All other points	14,742
Pennsylavania:	
Philadelphia	364,570
Pittsburgh	50,936
Reading	16,775
Scranton	35,324
All other points	92,946
Rhode Island:	
Providence	319,508
All other points	265,494
South Carolina:	
Charleston	335
Columbia	30
Tennessee:	
Knoxville	260
Memphis	285
Vermont:	
Burlington	18,796
All other points	88,183
Virginia: All points	4,923
Washington, D. C	47,732
West Virginia: Wheeling, Parkersburg, Windom, and all other points	5,463
Wisconsin:	
Milwaukee	18,809
All other points	315
Total	11,056,709

LOBSTERS.

Destination.	Pounds.
Alabama:	
Birmingham	50
Mobile	40
California: Los Angeles	200
Colorado:	
Colorado Springs	12
Denver	1,749
Connecticut:	
Bridgeport	3,653
Hartford	3,105
Meriden	454
New Britain	100
New Haven	3,500
Stamford	1,175
Waterbury	630
All other points	4,361
Delaware: Wilmington	590
Georgia: Atlanta	126
Illinois:	
Chicago	20,996
All other points	330
Indiana:	
Indianapolis	450
All other points	250
Iowa: Des Moines	72
Kentucky:	
Louisville	307
All other points	500
Maine: All points	86
Maryland: Baltimore	6,557
Massachusetts: All points	384,177
Michigan:	
Detroit	2,356
All other points	830

Fresh and frozen fishery products distributed through Boston, Mass., during September, 1922—Continued.

LOBSTERS—Continued.

Destination.	Pounds.	Destination.	Pounds.
Minnesota:		North Carolina:	
Minneapolis and St. Paul	4,036	Greensboro	125
All other points	50	Southern Pines	78
Missouri:		Ohio:	
Kansas City	300	Cincinnati	1,655
All other points	1,955	Cleveland	4,098
Nebraska: Omaha	1,687	Columbus	960
New Hampshire:		Dayton	449
Manchester	100	Toledo	2,520
All other points	3,456	Youngstown	367
New Jersey:		All other points	1,190
Elizabeth	30	Oklahoma: Oklahoma City	90
Newark	1,143	Pennsylvania:	
Trenton	295	Philadelphia	41,010
All other points	9,685	Pittsburgh	6,931
New York:		Reading	610
Albany	7,841	Scranton	1,190
Amsterdam	470	All other points	3,282
Auburn	166	Tennessee: Memphis	260
Binghamton	632	Utah: Salt Lake City	250
Buffalo	3,090	Vermont:	
Elmira	67	Burlington	725
New Rochelle	100	All other points	1,378
New York	42,665	Virginia: Lynchburg and all other points	232
Rochester	4,477	Washington, D. C.	5,175
Schenectady	1,325	West Virginia: Wheeling, Huntington, and all other points	793
Syracuse	4,193	Wisconsin:	
Troy	2,390	Milwaukee	2,636
Utica	3,333	All other points	329
Watertown	727		
All other points	9,153	Total	616,355

CLAMS.

CANADA.		UNITED STATES—continued.	
Montreal	470	New York:	
Toronto, Megantic, and all other points	554	Albany	706
UNITED STATES.		Buffalo	1,200
Connecticut:		New York City	150
Bridgeport	646	Rochester	1,140
Meriden	1,630	Schenectady	1,370
New Britain	718	Watertown	333
Stamford	90	All other points	1,968
Waterbury	4,543	Ohio:	
All other points	22,477	Cleveland	1,355
Delaware: Wilmington	250	Toledo	120
Illinois: Chicago	1,750	Pennsylvania:	
Maine: All points	1,961	Philadelphia	3,840
Massachusetts: All points	279,456	Pittsburgh	690
Michigan: All points	1,115	All other points	30
Missouri: St. Louis and all other points	595	Rhode Island: All points	133
Nebraska:		Vermont:	
Omaha	220	Burlington	270
All other points	360	All other points	4,326
New Hampshire:		Washington, D. C.	60
Manchester	500		
All other points	3,938	Total	338,964

Fresh and frozen fishery products distributed through Boston, Mass., during September, 1922—Continued.

OYSTERS.

Destination.	Gallons.	Destination.	Gallons.
CANADA.		UNITED STATES—continued.	
Montreal	25	New York:	
All other points	89	Albany	32
		Buffalo	50
UNITED STATES.		Schenectady	9
		All other points	101
Connecticut:		North Dakota: Fargo	6
Stamford	29	Ohio: Cleveland	30
Waterbury	17	Pennsylvania:	
All other points	35	Philadelphia	35
Maine:		All other points	21
Bangor	54	Rhode Island: All points	8
All other points	846	Vermont:	
Massachusetts: All points	7,635	Burlington	64
New Hampshire:		All other points	271
Manchester	24		
All other points	677	Total	10,068
New Jersey: Trenton	10		

SCALLOPS.[1]

Colorado: Denver	8	Ohio:	
Indiana: Indianapolis	2	Cincinnati	1
Maine: All points	1	Cleveland	30
Maryland: Baltimore	3	All other points	3
Massachusetts: All points	386	Utah: Salt Lake City	4
Minnesota: Minneapolis and St. Paul	10		
New York:		Total	478
Binghamton	3		
New York City	11		
Watertown	5		
All other points	11		

[1] This being the first month of the season in which long-distance shipments are made, consignments leaving the State did not commence until the 13th of the month.

SHIPPING RATES.

LESS-THAN-CARLOAD SHIPMENTS IN CARLOAD LOTS.

A noteworthy saving for receivers of Boston fish in New York and Philadelphia has recently been effected by L. H. Young, forwarder of Boston, in the initiation of a system of transfer by which consignors in these cities save one-half the difference between the cost of less-than-carload shipments and carload shipments on less-than-carload quantities. Consignments from Boston to New York and Philadelphia are collected from practically all local dealers and combined for shipment in carload lots. Upon arriving at destination the car lots are distributed to various purchasers by a representative of the Boston forwarder. Railroad records show that carload consignments of Boston fish to these cities have more than doubled since the establishment of this system in April, 1922. The possibility of effecting like economies on shipments to other large consuming centers is therefore worthy of consideration.

In the appended statistical table the total "net" weight of seafood shipments from Boston to 10 representative cities is shown

by days for the last three weeks of September, 1922. On the basis of car-opening privileges provided under the tariff (now used extensively in the halibut and salmon trade [2]) all of the cities shown in this table present possible centers to which carloads of Boston sea food could be shipped.

Sea-food shipments from Boston, Mass., to 10 cities shown by days for last three weeks of September, 1922, indicating prospective carload markets for Boston sea food under tariff permitting car opening en route.

[Figures in boldface type show particular days on which carload combinations are possible.]

September, 1922.	Net weight in pounds.									
	Scranton, Pa.	Washington, D. C.	Rochester, N. Y.	Syracuse, N. Y.	Albany, N. Y.	Baltimore, Md.	Pittsburgh, Pa.	Chicago, Ill.	Detroit, Mich.	Cleveland, Ohio.
11. Monday	8,000	2,890	9,469	3,690	7,708	9,010	8,275	9,250	2,960	3,639
12. Tuesday	260	2,385	3,438	2,625	8,133	9,362	3,202	12,768	4,110	3,328
13. Wednesday	180	5,759	5,232	2,098	2,431	12,615	2,377	3,887	385	709
14. Thursday	....	320	1,185	435	2,020	4,471	100	2,740	26	255
15. Friday	25	580	225	585	745	733	....	1,020	....	....
16. Saturday	....	750	2,004	....	335	700	2,634	6,108	2,456	3,758
18. Monday	8,525	3,730	9,356	3,175	2,565	11,472	7,796	9,668	3,618	5,493
19. Tuesday	675	3,860	4,742	3,025	6,521	10,695	4,175	10,950	4,500	3,275
20. Wednesday	150	3,640	6,664	1,660	3,938	7,825	1,690	3,056	585	350
21. Thursday	20	700	1,850	700	950	4,566	140	1,365	75	293
22. Friday	....	275	770	490	831	476	85	1,165	....	30
23. Saturday	....	1,100	800	....	8	3,975	2,365	6,442	3,407	3,980
25. Monday	9,045	4,399	9,001	3,790	14,180	14,275	7,417	13,132	4,131	7,685
26. Tuesday	250	6,050	5,910	2,975	8,099	12,655	2,170	10,590	4,372	2,652
27. Wednesday	180	3,150	4,938	2,210	1,765	2,370	1,620	3,889	676	333
28. Thursday	....	125	1,362	982	1,520	4,628	395	1,883	65	50
29. Friday	25	....	1,250	480	375	2,577	....	1,565	....	75
30. Saturday	20	1,215	1,505	150	235	2,900	3,790	7,852	4,483	5,924

FREIGHT AND EXPRESS RATES.

The data for the freight and express rates on shipments of fresh and frozen fish and fishery products from Boston, Mass., were supplied by the Interstate Commerce Commission, Washington, D. C. The distances shown were figured from the War Department Table of Distances and the Official Railway Guide.

[2] *See* Trade in Fresh and Frozen Fishery Products and Related Marketing Considerations in Chicago, Ill. (B. F. Economic Circular No. 54, issued Dec. 30, 1921); Trade in Fresh and Frozen Fishery Products and Related Marketing Considerations in Minneapolis and St. Paul, Minn. (B. F. Economic Circular No. 55, issued Feb. 8, 1922), both by L. T. Hopkinson; and Trade in Fresh and Frozen Fishery Products and Related Marketing Considerations in Seattle, Wash. (B. F. Document No. 930, Appendix VI, Report of U. S. Commissioner of Fisheries for 1922, issued Aug. 5, 1922), by L. T. Hopkinson and W. P. Studdert.

Freight and express rates applicable on shipments of fresh and frozen fish, lobsters, clams, oysters, and scallops, from Boston, Mass., together with short-line distances.

[Notes to reference figures are grouped at end of table.]

From Boston, Mass., to—	Short-line distance in miles	Rate in dollars and cents per 100 pounds.						
		Freight.[1]					Express: Carload and less-than-carload lots.	
		Carload lots.		Less-than-carload lots.				
		Clams, oysters, scallops, in shell [2 3] or bulk [4]; lobsters, live [3 5]; fish, fresh or frozen.[3 6]	Clams, oysters, scallops, shucked [7 8]; lobster meat, fresh.[8 9]	Clams, oysters, scallops, in shell.[2]	Clams, oysters, scallops, shucked [7]; lobster meat, fresh.[9]	Lobsters, live [5]; fish, fresh or frozen.[6]	Fish, fresh or frozen [10 11 12]; clams, oysters, scallops.[10 13 14 15]	Lobsters.[10 16 17]
CANADA.								
Winnipeg: Manitoba	1,741	[18] 1.68 [19] 2.13 [20] 1.92	[21] 2.79	2.535	[21] 4.205	3.23	6.40	8.40
Ontario:								
Hamilton	576	.72	1.08	.945	1.62	1.08	2.45	3.25
Toronto	612	.72	1.08	.945	1.62	1.08	2.80	3.75
Quebec:								
Levis	491	.70	1.055	.935	1.585	1.055	2.45	3.15
Megantic	494	.70	1.055	.935	1.585	1.055	1.90	2.30
Montreal	329	.655	.98	.875	1.47	.98	1.90	2.50
Quebec	501	.70	1.055	.935	1.585	1.055	2.45	3.15
UNITED STATES.								
Alabama:								
Birmingham	1,225	[21] 1.32 [22] .885	[21] 1.55 2.035	1.74	3.055	[22] 2.035	4.10	5.47
Mobile	1,466	[21] 1.445 [22] .97	[21] 1.72 2.26	1.945	3.39	[22] 2.26	4.62	6.16
California: Los Angeles	3,273	[4 23] 2.92 4.42 [20] 3.755	[21] 5.335 6.165	5.335	[21] 6.165 9.25	6.165	[24] 7.88 [25] 4.28 10.55	14.06
Colorado:								
Colorado Springs	2,090	[26] 1.70 2.615 [20] 2.24	[21] 3.56 4.12	3.385	[21] 4.865 6.18	4.12	6.29	8.38
Denver	2,052	[26] 1.70 2.615 [20] 2.24	[21] 3.56 4.12	3.385	[21] 4.865 6.18	4.12	6.18	8.24
Connecticut:								
Bridgeport	156	.46	.665	.585	1.00	.665	1.09	1.45
Hartford	117	.41	.615	.525	.925	.615	1.09	1.45
Meriden	128	.425	.635	.54	.955	.635	1.09	1.45
New Britain	126	.425	.635	.54	.955	.635	1.09	1.45
New Haven	139	.44	.655	.555	.985	.655	1.09	1.45
South Norwalk	170	.475	.665	.60	1.00	.665	1.09	1.45
Stamford	179	.485	.665	.60	1.00	.665	1.09	1.45
Waterbury	142	.445	.665	.565	1.00	.665	1.09	1.45
Delaware: Wilmington	353	.475	.665	.565	1.00	.665	1.61	2.14
District of Columbia: Washington	463	.65	.855	.745	1.285	.855	1.92	2.56
Florida: Jacksonville	1,218	[21] 1.18 [22] .79	[21] 1.395 1.835	1.575	2.755	[22] 1.835	4.06	5.41
Georgia: Atlanta	1,111	[21] 1.26 [22] .84	[21] 1.49 1.965	1.68	2.95	[22] 1.965	3.68	4.91
Illinois: Chicago	1,034	[27] .755 .945	1.42	1.245	2.13	1.42	2.75	3.67
Indiana: Indianapolis	965	[27] .70 .88	1.32	1.16	1.98	1.32	2.70	3.60
Iowa:								
Des Moines	1,392	[26] 1.16 1.38 [20] 1.315	[21] 2.025 2.045	1.82	[21] 2.975 3.22	2.145	3.68	4.91
Sioux City	1,544	[26] 1.445 1.635 [20] 1.43	[21] 2.41 2.635	2.235	[21] 3.345 3.955	2.635	4.47	5.96
Waterloo	1,294	[26] 1.07 1.29 [20] 1.245	[21] 1.89 1.965	1.685	[21] 2.795 2.95	1.965	3.59	4.78

For footnotes see page 12.

Freight and express rates applicable on shipments of fresh and frozen fish, lobsters, clams, oysters, and scallops, from Boston, Mass., together with short-line distances—Continued.

From Boston, Mass., to—	Short-line distance in miles.	Rate in dollars and cents per 100 pounds.						
		Freight.[1]					Express: Carload and less-than-carload lots.	
		Carload lots.		Less-than-carload lots.				
		Clams, oysters, scallops, in shell [2,3] or bulk [4]; lobsters, live [3,5]; fish, fresh or frozen.[3,6]	Clams, oysters, scallops, shucked [7,8]; lobster meat, fresh.[8,9]	Clams, oysters, scallops, in shell.[2]	Clams, oysters, scallops, shucked [7]; lobster meat, fresh.[9]	Lobsters, live [5]; fish, fresh or frozen.[6]	Fish, fresh or frozen [10,11,12]; clams oysters, scallops.[10,13,14,15]	Lobsters.[10,16,17]
UNITED STATES—con.								
Kentucky: Louisville	1,059	[27] .755 .945	1.42	1.245	2.13	1.42	2.81	3.74
Louisiana: New Orleans	1,607	[21] 1.445 [22] .97	[21] 1.72 2.26	1.945	3.39	[22] 2.26	4.94	6.58
Maine: Bangor	250	.595	.885	.75	1.33	.885	1.46	1.94
Maryland: Baltimore	423	.565	.79	.695	1.185	.79	1.71	2.28
Massachusetts:								
Fall River	46	.33	.49	.415	.735	.49	.77	1.03
Holyoke	107	.39	.585	.495	.88	.585	.94	1.25
New Bedford	52	.335	.50	.425	.75	.50	.94	1.25
Pittsfield	151	.445	.635	.54	.955	.635	1.09	1.45
Springfield	99	.39	.585	.495	.88	.585	.94	1.25
Michigan: Detroit	750	[27] .59 .735	1.11	.97	1.665	1.11	2.50	3.33
Minnesota:								
Minneapolis	1,454	[27] 1.11 1.29	[28] 2.18 1.95	1.695	[28] 3.045 2.925	1.95	4.00	5.33
St. Paul	1,444	[27] 1.11 1.29	[28] 2.18 1.95	1.695	[28] 3.045 2.925	1.95	4.00	5.33
Missouri:								
Kansas City	1,466	[26] 1.42 1.635 [20] 1.43	[21] 2.35 2.575	2.145	[21] 3.345 3.87	2.575	4.00	5.33
St. Louis	1,230	[26] .885 1.105	1.66	1.455	2.49	1.66	3.02	4.02
Nebraska: Omaha	1,527	[26] 1.42 1.635 [20] 1.43	[21] 2.35 2.575	2.145	[21] 3.345 3.87	2.575	4.21	5.61
New Hampshire: Manchester	57	.37	.55	.47	.825	.55	.77	1.03
New Jersey:								
Atlantic City	375	.44	.69	.565	1.035	.69	1.61	2.14
Elizabeth	248	.365	.565	.475	.85	.565	1.46	1.94
Jersey City	236	.365	.565	.475	.85	.565	1.46	1.94
Newark	244	.365	.565	.475	.85	.565	1.46	1.94
Trenton	292	.365	.565	.475	.85	.565	1.46	1.94
New York:								
Albany	201	.46	.635	.54	.955	.635	1.09	1.45
Amsterdam	268	.475	.725	.63	1.09	.725	1.19	1.59
Auburn	376	.51	.75	.65	1.125	.75	1.46	1.94
Binghamton	345	.50	.725	.63	1.09	.725	1.35	1.80
Buffalo	499	.575	.845	.745	1.27	.845	1.82	2.42
Canandaigua	424	.51	.75	.65	1.125	.75	1.71	2.28
Elmira	402	.51	.75	.65	1.125	.75	1.46	1.94
Glens Falls	229	.475	.665	.565	1.00	.665	1.19	1.59
Jamestown	567	.595	.90	.785	1.35	.90	1.92	2.56
Mount Vernon	221	.50	.665	.60	1.00	.665	1.19	1.59
New Rochelle	218	.50	.665	.60	1.00	.665	1.19	1.59
New York City	235	.50	.665	.60	1.00	.665	1.19	1.59
Oneonta	283	.50	.725	.63	1.09	.725	1.35	1.80
Poughkeepsie	228	.50	.665	.60	1.00	.665	1.09	1.45
Rochester	430	.51	.75	.65	1.125	.75	1.71	2.28
Schenectady	219	.475	.665	.565	1.00	.665	1.09	1.45
Syracuse	350	.475	.725	.63	1.09	.725	1.61	2.14
Troy	209	.475	.665	.565	1.00	.665	1.09	1.45
Ushers	192	.475	.665	.565	1.00	.665	1.09	1.45
Utica	297	.475	.725	.63	1.09	.725	1.46	1.94
Watertown	364	.63	.97	.82	1.455	.97	1.46	1.94

For footnotes see page 12.

Freight and express rates applicable on shipments of fresh and frozen fish, lobsters, clams, oysters, and scallops, from Boston, Mass., together with short-line distances—Continued.

From Boston, Mass., to—	Short-line distance in miles.	Rate in dollars and cents per 100 pounds.						
		Freight.[1]					Express: Carload and less-than-carload lots.	
		Carload lots.		Less-than-carload lots.				
		Clams, oysters, scallops, in shell [2,3] or bulk [4]; lobsters, live [3,5]; fish, fresh or frozen.[3,6]	Clams, oysters, scallops, shucked [7,8]; lobster meat, fresh.[8,9]	Clams, oysters, scallops, in shell.[2]	Clams, oysters, scallops, shucked [7]; lobster meat, fresh.[9]	Lobsters, live [5]; fish, fresh or frozen.[6]	Fish, fresh or frozen [10,11,12]; clams, oysters, scallops.[10,13,14,15]	Lobsters.[10,16,17]
UNITED STATES—con.								
North Carolina:								
Asheville	940	[21] 1.14 [22] .755	[21] 1.41 1.86	1.59	2.79	[22] 1.86	3.23	4.30
Charlotte	843	[21] .99 [22] .69	[21] 1.22 1.62	1.425	2.43	[22] 1.62	2.86	3.81
Greensboro	750	[21] .90 [22] .63	[21] 1.13 1.515	1.32	2.275	[22] 1.515	2.60	3.47
Southern Pines	803	[21] .99 [22] .69	[21] 1.22 1.62	1.425	2.43	[22] 1.62	2.86	3.81
North Dakota: Fargo	1,686	[26] 1.695 1.875 [20] 1.74	[29] 2.91 2.68 [30] 2.82	2.425	[29] 3.91 3.795 [30] 4.23	2.82	4.79	6.38
Ohio:								
Cincinnati	945	[27] .655 .82	1.235	1.085	1.85	1.235	2.70	3.60
Cleveland	682	[27] .535 .67	1.01	.885	1.515	1.01	2.23	2.97
Columbus	820	[27] .59 .735	1.11	.97	1.665	1.11	2.54	3.39
Dayton	890	[27] .635 .795	1.195	1.045	1.79	1.195	2.70	3.60
Toledo	795	[27] .59 .735	1.11	.97	1.665	1.11	2.50	3.33
Youngstown	692	[27] .535 .67	1.01	.885	1.515	1.01	2.13	2.84
Oklahoma: Oklahoma City	1,773	[26] 2.36 2.575 [20] 2.045	[21] 3.16 3.635	3.115	[21] 4.405 5.455	3.635	5.30	7.07
Pennsylvania:								
Philadelphia	326	.50	.665	.60	1.00	.665	1.61	2.14
Pittsburgh	679	.595	.90	.785	1.35	.90	2.13	2.84
Reading	361	.50	.725	.63	1.09	.725	1.61	2.14
Scranton	381	.50	.725	.63	1.09	.725	1.46	1.94
Rhode Island: Providence	43	.32	.475	.405	.715	.475	.77	1.03
South Carolina:								
Charleston	974	[21] 1.115 [22] .745	[21] 1.41 1.735	1.495	2.605	[22] 1.735	3.33	4.44
Columbia	938	[21] 1.065 [22] .705	[21] 1.26 1.695	1.44	2.545	[22] 1.695	3.33	4.44
Tennessee:								
Knoxville	971	[21] 1.20 [22] .795	[21] 1.41 1.86	1.59	2.79	[22] 1.86	3.33	4.44
Memphis	1,392	[21] 1.34 [22] .90	[21] 1.595 2.095	1.805	3.145	[22] 2.095	3.85	5.13
Utah: Salt Lake City	2,564	[4,23] 2.92 3.72 [26] 3.525 [20] 3.18	[21] 4.74 5.37	4.535	[21] 6.11 8.055	5.37	8.32	11.09
Vermont: Burlington	234	5.85	.87	.74	1.305	.87	1.35	1.80
Virginia:								
Bedford	661	1.07	1.405	1.215	2.11	1.405	2.44	3.25
Lynchburg	636	.725	1.025	.90	1.54	1.025	2.44	3.25
Richmond	578	.655	.865	.745	1.30	.865	2.18	2.91
West Virginia:								
Hinton	754	[27] .62 .775	1.165	1.02	1.75	1.165	2.70	3.60
Huntington	901	[27] .62 .775	1.165	1.02	1.75	1.165	2.75	3.67
Parkersburg	821	[27] .535 .67	1.01	.885	1.515	1.01	2.50	3.33

For footnotes see page 12.

Freight and express rates applicable on shipments of fresh and frozen fish, lobsters, clams, oysters, and scallops, from Boston, Mass., together with short-line distances—Continued.

From Boston, Mass., to—	Short-line distance in miles.	Rate in dollars and cents per 100 pounds.						
		Freight.[1]					Express: Carload and less-than-carload lots.	
		Carload lots.		Less-than-carload lots.				
		Clams, oysters, scallops, in shell[2 3] or bulk[4]; lobsters, live[3 5]; fish, fresh or frozen.[3 6]	Clams, oysters, scallops, shucked[7 8]; lobster meat, fresh.[8 9]	Clams, oysters, scallops, in shell.[2]	Clams, oysters, scallops, shucked[7]; lobster meat, fresh.[3]	Lobsters, live[5]; fish, fresh or frozen.[6]	Fish, fresh or frozen[10 11 12]; clams, oysters, scallops.[10 13 14 15]	Lobsters.[10 16 17]
UNITED STATES—con.								
West Virginia—Con.								
Wheeling	745	[27] .535 .595	.90	.785	1.35	.90	2.23	2.97
Wisconsin: Milwaukee	1,119	[27] .755 .945	1.42	1.245	2.13	1.42	3.02	4.02

EXPLANATION OF REFERENCE FIGURES IN PRECEDING TABLE.

1 Freight rates do not include the cost of refrigeration, icing, or reicing, the charges for which, as employed, are in addition to the transportation rate.
2 In bags or barrels.
3 Minimum weight, 24,000 pounds.
4 Minimum weight, 30,000 pounds.
5 In barrels, boxes, or crates.
6 Not otherwise provided for, in barrels or boxes.
7 In tin cans in packages, in iron or steel cans loose or in packages, or in oyster carriers or refrigerators.
8 Minimum weight, 15,000 pounds.
9 In metal cans in barrels or boxes.
10 On products to Canada.—Refrigeration: Ice to be furnished by shipper at owner's expense.
11 On fish to Canada.—Weight basis: 25 per cent added to net weight, unless actual weight is less at time of shipment; provided, that when any shipment of iced fish weighs 100 per cent or more gross than actual net weight the charge must be made on basis of gross weight, less 25 per cent for ice.
12 On fish to United States, except in carload lots to Los Angeles, Calif. (footnote 25).—Weight basis: 25 per cent added to net weight of fish, unless actual gross weight is less at time of shipment.
13 In shell, glass jars, canned, or in bulk.
14 When shipped in bulk, estimate at 12 pounds per gallon. Shippers must mark upon each package the number of gallons contained therein.
In glass jars, estimate 24 pints at 45 pounds, 36 pints at 65 pounds, 48 pints at 90 pounds, and 48 half pints at 50 pounds.
The following estimated weights will apply to oysters in metal cans with or without ice, when packed in boxes: One-tenth gallon cans, 1¼ pounds each; pint cans, 1½ pounds each; standard or three-fourths cans, 2 pounds each; one-fifth gallon cans, 2½ pounds each; full-quart cans, 3 pounds each; half-gallon cans, 6 pounds each; gallon cans, 12 pounds each. Shippers must mark exact number and kind of cans on case.
Gross weight at time of shipment will apply when less than estimated weight shown.
Oysters in paper cans without ice, charge on basis of gross weight.
15 Carloads.—Minimum billing weight, 12,000 pounds on following basis: When in shell, actual weight; shucked oysters in carriers, estimate at 12 pounds per gallon; shucked oysters in naked cans without other packing, charge on basis of actual weight of oysters and containers.
No charge will be made for transportation of chopped ice, not exceeding 3,000 pounds in weight, packed on top or around cans; nor, when refrigerator cars are used, will any charge be made for transportation of ice in the bunkers. The cost of all ice furnished by the express company must be paid by shipper or consignee.
16 On less-than-carloads lots: Minimum charge, 38 cents per shipment.
17 When in iced containers add 50 per cent to net weight of lobsters, unless actual gross weight at time of shipment is less. Net weight of lobsters must be marked on container.
18 Applies on clams, oysters, scallops in shell only.
19 Applies on live lobsters only.
20 Applies on fish only.
21 Applies on clams, oysters, scallops only.
22 No freight rates found covering this movement on live lobsters.
23 Applies on oysters only, in shell, in bags.
24 Applies on fish only, in less-than-carload lots, to Los Angeles, Calif.
25 Applies on fish only, in carload lots, to Los Angeles, Calif.; $83.16 additional per car for refrigeration. Minimum weight, 20,000 pounds on basis of net weight.
26 Applies on oysters and clams in shell only, straight or mixed.
27 Applies on oysters and clams in shell only.
28 Applies on scallops in shell only.
29 Applies on oysters, shucked, or oyster meats only.
30 Applies on lobster meat only.

FISH FROZEN IN 1922.

The following table gives the number of pounds of each species of fish frozen in Boston for each month during 1922.

Fish frozen in Boston, monthly, by species, 1922.[1]

Species.	January.	February.	March.	April.	May.	June.	July.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Bluefish (all trade sizes)	...	...	...	...	...	...	381
Butterfish (all trade sizes)	...	...	...	...	129	22,931	63,999
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	...	...	46,800	5,026	750	...	36,370
Cod, haddock, pollock, hake	5,600	33,032	31,250	...	4,265	11,760	26,915
Flounders	(2)	(2)	(2)	(2)	(2)	(2)	17,915
Halibut (all trade sizes)	5,945	11,500	33,550	46,025	77,969	83,102	187,381
Herring, sea (including alewives and bluebacks)	...	3,800	...	13,260	73,800	36,529	17,900
Lake trout	...	...	...	98	375	...	665
Mackerel (excepting Spanish)	47,551	24,425	...	2,515	944,062	420,747	122,533
Pike perches and pike or pickerel	(2)	(2)	(2)	(2)	(2)	(2)	...
Salmon, silver and fall	550	1,050	415	...	1,068	9,265	2,998
Salmon, all other	...	...	...	4,000	18,105	70,126	5,133
Scup (porgies)	(2)	(2)	(2)	(2)	(2)	(2)	21,900
Shad and shad roe	...	...	1,000	4,835	...	550	18,800
Shellfish	(2)	(2)	(2)	(2)	(2)	(2)	2,729
Smelts, eulachon, etc	148,073	108,844	8,847	576	...	...	...
Squeteagues or "sea trout"	...	...	...	76	...	...	...
Squid	...	...	...	202,208	378,245	54,150	15,725
Sturgeon, and spoonbill cat	(2)	(2)	(2)	(2)	(2)	(2)	380
Whitefish	...	...	...	1,500	...	...	...
Whiting	...	680	5,903	...	168,980	234,275	170,195
Miscellaneous fish	57,823	115,763	75,263	26,838	87,610	263,241	302,681
Total	265,542	299,094	203,028	306,957	1,755,358	1,206,676	1,014,600

Species.	August.	September.	October.	November.	December.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Bluefish (all trade sizes)	241	3,110	1,119	...	...	4,851
Butterfish (all trade sizes)	15,988	21,840	1,403	970	...	127,260
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	11,875	8,565	2,200	2,000	...	113,586
Cod, haddock, pollock, hake	34,702	40,395	75,108	55,109	18,254	336,390
Flounders	18,200	22,400	8,170	...	...	66,685
Halibut (all trade sizes)	7,479	51,198	33,832	248	64,845	603,074
Herring, sea (including alewives and bluebacks)	28,435	180,520	339,465	51,615	25,825	771,149
Lake trout	...	100	...	...	...	1,238
Mackerel (excepting Spanish)	186,444	923,124	262,053	22,273	60,050	3,015,777
Pike perches and pike or pickerel	...	3,682	725	900	160	5,467
Salmon, silver and fall	97,678	44,109	134,964	7,223	2,100	301,420
Salmon, all other	21,094	46,163	17,661	...	...	182,282
Scup (porgies)	570	23,320	2,829	...	782	49,401
Shad and shad roe	...	3,125	1,080	66	...	29,456
Shellfish	8,693	18,621	7,021	25,927	8,021	71,012
Smelts, eulachon, etc	...	1,115	3,425	50	640	271,570
Squeteagues or "sea trout"	...	...	400	...	...	476
Squid	870	3,770	27,755	680	...	683,403
Sturgeon, and spoonbill cat	271	...	...	98	...	749
Whitefish	...	...	...	300	24,200	26,000
Whiting	59,095	40,880	24,415	17,433	...	721,856
Miscellaneous fish	239,454	227,523	147,133	17,027	2,725	1,563,081
Total	731,089	1,663,560	1,090,758	201,919	207,602	8,946,183

[1] These statistics are furnished by the Bureau of Agricultural Economics, Department of Agriculture.
[2] Included with miscellaneous fish prior to July 15, 1922.

PER CAPITA CONSUMPTION DURING SEPTEMBER, 1922.

BOSTON FISH.

Massachusetts' consumption of Boston fish exceeds 1½ pounds per capita, more than five times the quantity used in Vermont, the State standing next as a per capita consumer of Boston fish. Moreover, this 1½ pounds of Massachusetts is thirty times greater than the average per capita consumption of the 29 other States receiving Boston fish.

It is also evident that some States that, by reason of the heavy shipments received, seem to be great consumers of Boston fish are in reality relatively light users. Instances are that Vermont is found to hold only eleventh place in the quantity of Boston fish received, but is second in per capita consumption, whereas Rhode Island, which is third in importance as a market for Boston fish, rates eighth as a per capita consumer. Similarly, New Hampshire, sixth in amount received, is reduced to sixteenth place as a per capita user.

Per capita consumption of fresh and frozen fish distributed through Boston during September, 1922.

Locality.	Quantity of fresh and frozen fish shipped.	Population.	Per capita consumption.
	Pounds.	*Number.*	*Pounds.*
Canada	132,433	[1] 7,206,643	0.01838
United States:			
Massachusetts	6,023,525	3,852,356	1.5634
Vermont	106,979	352,428	.30355
Connecticut	400,961	1,380,631	.29041
New York	2,257,697	10,385,227	.21740
Maine	117,479	768,014	.15296
District of Columbia	47,732	437,571	.10908
Maryland	144,323	1,449,661	.09956
Pennsylvania	560,551	8,720,017	.06428
Delaware	12,955	223,003	.05809
Illinois	148,258	6,485,280	.02286
Michigan	54,642	3,668,412	.01490
New Jersey	44,853	3,155,900	.01421
Ohio	80,379	5,759,394	.01396
Rhode Island	585,002	604,397	.00968
Wisconsin	19,124	2,632,067	.00727
New Hampshire	274,258	443,083	.00619
Missouri	18,038	3,404,005	.00529
West Virginia	5,463	1,463,701	.00373
Colorado	2,918	939,629	.00311
Nebraska	3,233	1,296,372	.00249
Virginia	4,923	2,309,187	.00213
Minnesota	3,439	2,387,125	.00144
North Carolina	3,228	2,559,123	.00126
Indiana	1,748	2,930,390	.00060
Louisiana	895	1,798,509	.00050
Iowa	613	2,404,021	.00025
Tennessee	545	2,337,885	.00023
South Carolina	365	1,683,662	.00022
Florida	150	968,470	.00015
All other States		28,911,100	
Total	10,924,476	105,710,620	.10334
Grand total	11,056,709	112,917,263	.09792

[1] Canadian census 1911.

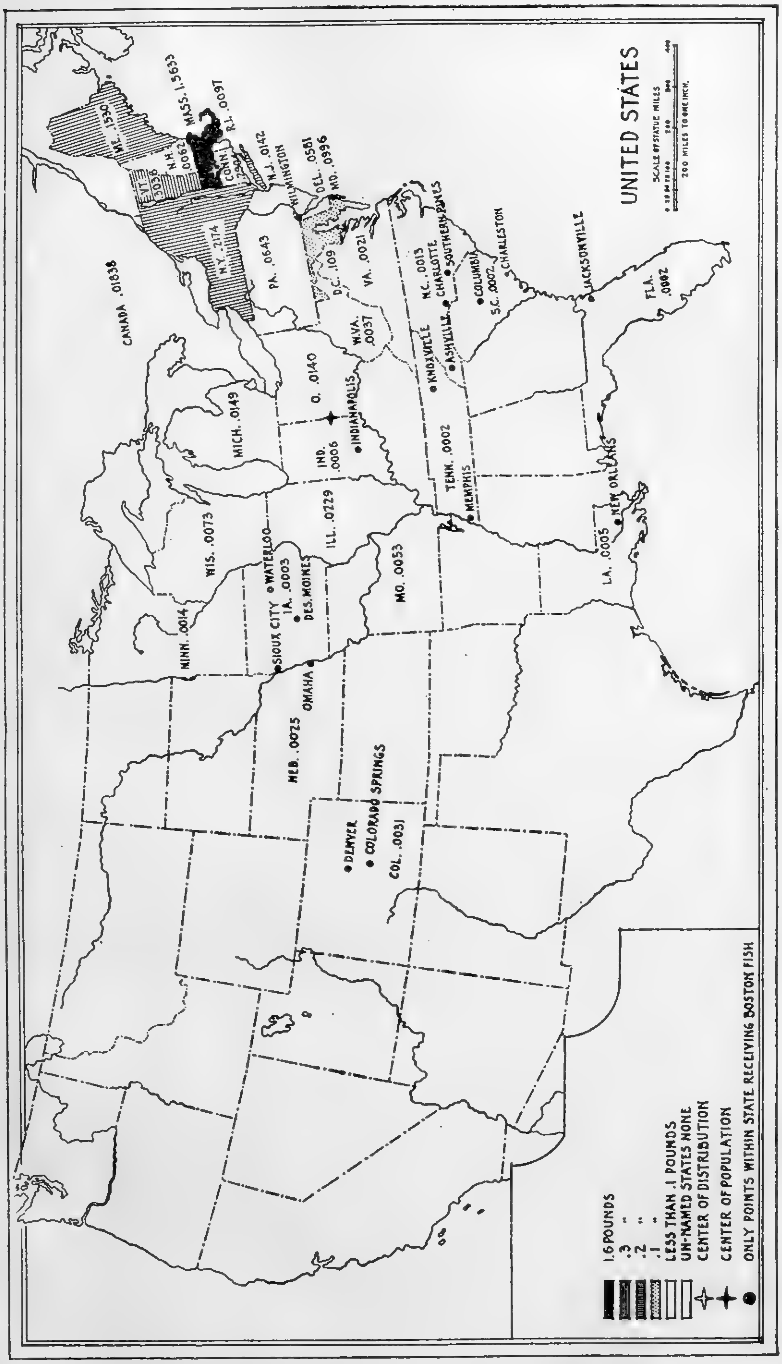

FIG. 2.—Per capita consumption of Boston fish for September, 1922, with center of distribution compared to center of population.

BOSTON LOBSTERS.

Massachusetts consumes eight times more Boston lobsters per capita than does Connecticut, the second largest user, and thirty-eight times more than the average per capita consumption for the other 30 States that receive lobsters from Boston.

A conspicuous deduction from the succeeding table is that whereas New York and Pennsylvania occupy second and third places in the quantity of Boston lobsters received, their per capita consumption is fifth and sixth, respectively. Conversely, the District of Columbia and New Hampshire, which rate ninth and eleventh in receipts, stand high in the list of consumers, being third and fourth. Illinois, with receipts of 21,000 pounds of Boston lobsters, than which only three States receive more, is eleventh in per capita consumption and only one place above Delaware, which received only 590 pounds. Ohio stands even lower than Delaware, though Boston lobster shipments to the former were more than 5 tons, and to the latter only 590 pounds.

The market for Boston lobsters is more widely dispersed than that for any other Boston sea food, Denver, Colo., and Los Angeles, Calif., being among the western purchasers.

Per capita consumption of lobsters distributed through Boston during September, 1922.

State.	Quantity of lobsters shipped.	Population.	Per capita consumption.
	Pounds.	*Number.*	*Pound.*
Massachusetts	384,177	3,852,356	0.09973
Connecticut	16,978	1,380,631	.01230
District of Columbia	5,175	437,571	.01183
New Hampshire	3,556	443,083	.00803
New York	80,629	10,385,227	.00776
Pennsylvania	53,023	8,720,017	.00608
Vermont	2,103	352,428	.00597
Maryland	6,557	1,449,661	.00452
New Jersey	11,153	3,155,900	.00353
Illinois	21,326	6,485,280	.00329
Delaware	590	223,003	.00265
Ohio	11,239	5,759,394	.00195
Colorado	1,761	939,629	.00187
Minnesota	4,086	2,387,125	.00171
Nebraska	1,687	1,296,372	.00130
Wisconsin	2,965	2,632,067	.00113
Michigan	3,186	3,668,412	.00087
Missouri	2,255	3,404,055	.00066
Utah	250	449,396	.00056
West Virginia	793	1,463,701	.00054
Kentucky	807	2,416,630	.00033
Indiana	700	2,903,390	.00024
Maine	86	768,014	.00011
Tennessee	260	2,337,885	.00011
Virginia	232	2,309,187	.00010
North Carolina	203	2,559,123	.00008
California	200	3,426,861	.00006
Alabama	90	2,348,174	.00004
Georgia	126	2,895,832	.00004
Oklahoma	90	2,028,283	.00004
Iowa	72	2,404,021	.00003
All other States		20,400,912	
Total	616,355	105,710,620	.00583

BOSTON CLAMS.

Boston clams are marketed in 15 States, Massachusetts taking almost five times more than the other 14 combined, which represents for Massachusetts a per capita disposal 1,800 per cent greater than the average for all other States receiving clams from Boston.

It is instructive to observe that though receiving only 250 pounds, and hence ranking thirteenth as a quantity buyer, Delaware takes precedence in per capita consumption of Boston clams over New York State, which purchases nearly 7,000 pounds and ranks third as a quantity market.

Per capita consumption of clams distributed through Boston during September, 1922.

Locality.	Gross weight of clams shipped.	Population, 1921.	Per capita consumption.
	Pounds.	*Number.*	*Pound.*
Canada	1,024	[1] 7,206,643	0.000142
United States:			
Massachusetts	279,456	3,852,356	.072542
Connecticut	30,104	1,380,631	.021805
Vermont	4,596	352,428	.013041
New Hampshire	4,438	443,083	.010016
Maine	1,961	768,014	.002553
Delaware	250	223,003	.001121
New York	6,867	10,385,227	.000661
Pennsylvania	4,560	8,720,017	.000523
Nebraska	580	1,296,372	.000447
Michigan	1,115	3,668,412	.000304
Illinois	1,750	6,485,280	.000269
Ohio	1,475	5,759,394	.000256
Rhode Island	133	604,397	.000220
Missouri	595	3,404,055	.000175
District of Columbia	60	437,571	.000137
All other States		57,930,380	
Total	337,940	105,710,620	.003197
Grand total	338,964	112,917,263	.003002

[1] Canadian census, 1911.

BOSTON OYSTERS.

Attention is directed to the fact that Massachusetts consumes exactly two-thirds of the entire quantity of oysters distributed from Boston, accomplishing this by a per capita use five times the amount of the average for the other 10 States that sent to Boston for supplies of this shellfish. The three States, New Hampshire, Maine, and Vermont, purchase 92 per cent of what oysters Boston does not sell in Massachusetts, and it is noticeable that all four States mentioned are closely comparable in per capita use and constitute a class unapproached by any of the other purchasers of this Boston product.

Per capita consumption of oysters distributed through Boston during September, 1922.

Locality.	Quantity of oysters shipped.	Population.	Per capita consumption.
	Gallons.	*Number.*	*Gallon.*
Canada	114	[1] 7,206,643	0.000016
United States:			
Massachusetts	7,635	3,852,356	.001982
New Hampshire	701	443,083	.001582
Maine	900	768,014	.001172
Vermont	335	352,428	.000951
Connecticut	81	1,380,631	.000059
New York	192	10,385,227	.000018
Rhode Island	8	604,397	.000013
North Dakota	6	645,730	.000009
Pennsylvania	56	8,720,017	.000006
Ohio	30	5,759,394	.000005
New Jersey	10	3,155,900	.000003
All other States		69,643,443	
Total	9,954	105,710,620	.000014
Grand total	10,068	112,917,263	.000089

[1] Canadian census, 1911.

BOSTON SCALLOPS.

During September, 1922, 478 gallons of scallops were received by wholesale dealers in Boston, of which 81 per cent were consumed in Massachusetts.

WHOLESALE AND RETAIL TRADE.

POPULATION OF BOSTON, 1920.

The population of Boston, Mass., according to the 1920 census, was as follows:

Native white:	
Native parentage	181,811
Foreign parentage	238,241
Mixed parentage	71,514
Total	491,566
Foreign-born white:	
Canadian	42,008
English	12,408
Irish	57,011
Italian	38,179
Russian	38,021
All other	51,292
Total	238,919
Negro	16,350
All other (orientals, etc.)	1,225
Total population	748,060

The membership in religious bodies in Boston, Mass., according to the 1920 census, was as follows:

Roman Catholic	294,914
Jewish congregations	17,975
All other	78,609
Total membership	391,498

SPECIES OF FISH HANDLED.

TRADE NAMES.

To avoid applying more than one name to certain species of fish in the following discussion of local trade, the appended list is included as a guide to readers.

Standard and local names of species of fish sold, Boston, Mass.

Name used in table.	Local name.	Name used in table.	Local name.
Alewives	Herring; alewives.	Squeteagues	Sea trout; squeteagues.
Blue pike	Blue pike; blues.	Striped bass	Rockfish; striped bass.
Buffalo fish	Buffalo carp; buffalo fish.	Suckers	Suckers; mullet.
Cunners	Sold skinned as perch.	Tautog	Blackfish; tautog.
Pike	Jack; pickerel; grass pike.	Yellow perch	Yellow perch; lake perch; perch.
Sea bass	Gray bass; sea bass.	Yellow pike	Pike; yellow pike.

IMPORTANT COMMERCIAL SPECIES.

The sale of fresh and frozen fishery products in Boston proper is made up in the main of cod, haddock, halibut, mackerel, swordfish, and lobsters. On the basis of quantity sale these six species constitute approximately 80 per cent of the total amount of all fresh and frozen fish sold in the city. In addition, a moderate demand exists for alewives, butterfish, carp, flounders, salmon, smelts, suckers, clams, crabs, and oysters.

SPECIES IN MODERATE DEMAND.

Some 54 species find a moderate demand in Boston. That these fishes are not consumed in greater quantity the dealers explain by the reasons shown in the following table:

Species of fish for which there is a small sale, Boston, Mass.

Species.	Reasons given for small sale, and other notes.
Bluefish	Popular, but price considered high.
Blue pike	Popular among Jewish people.
Bonito	Bought chiefly by Italians.
Buffalo fish	Bought chiefly by Jewish people.
Bullheads	Supply limited; popular with Greek people.
Catfish (fresh water)	Unpopular.
Catfish (salt water)	Popular with Italians.
Chubs	Popular, but supply limited.
Ciscoes	Popular with Jewish people.
Cunners	Supply limited.
Cusk	Unpopular.
Eels	Limited demand exists among all classes.
Hake	Unpopular fresh; largely slack salted; sometimes substituted for cod and haddock when prices are high.
Hickory shad	Unpopular.
Horse mackerel	Popular fresh among Italians; also canned as tuna.
Lake herring	Popular with Jewish people.
Lake trout	Popular in hotels and first-class restaurants; supply limited, demand increasing.
Perch, white	Supply limited; popular with Chinese and Jewish people.
Perch, yellow	Do.
Perch, yellow (fresh water)	Bought chiefly by Jewish people.
Pike or pickerel	Popular, but supply limited.
Pike, yellow	Used chiefly by Jewish people.
Pollock	Unpopular.
Pompano	Supply limited and price considered high; demand decreasing.
Red snapper	Used chiefly by restaurants and foreign people.
Rock bass	Popular with Jewish and Greek people.
Sauger	Unpopular.
Scup	Popular in season.
Sea bass	Popular, but supply limited.
Shad	Popular in season.
Sharks	Bought chiefly by Italians.
Sheepshead (fresh water)	Unpopular except among Jewish people; demand decreasing.
Sheepshead (salt water)	Supply limited.
Skates	Unpopular except with a few Italians.
Squeteagues or "sea trout"	Used chiefly by hotels and restaurants; supply limited.
Squid	Few used by Italians; used chiefly for bait.
Striped bass	Very popular, but price considered too high.
Sturgeon	Popular, but supply limited.
Suckers (salt water)	Unpopular.
Suckers (fresh water)	Used mostly by Jewish people.
Sunfish	Supply limited.
Tautog	Unpopular; demand decreasing.
Tilefish	Do.
Tomcod	Do.
White bass	Popular, but supply limited.
Whitefish	Popular with Jewish people.
Whiting	Popular with Italians.
Scallops	Supply limited.
Mussels	Unpopular; used mostly for bait.
Cockles	Do.
Winkles	Do.
Shrimp	Demand increasing; used as substitute for lobsters.
Tongues, cheeks, and sounds	Chiefly salted; fresh, demand limited to certain classes.
Frogs	Supply limited; price considered high.

TRADE IN WESTERN HALIBUT AND SALMON.

The extent of Boston's trade in western halibut and salmon is shown in the appended table of carload arrivals of these fishes during the year ending September 30, 1922. During this period Boston received 169 cars of halibut and salmon, of which 78 were of halibut, 65½ of salmon, and 24 of mixed halibut and salmon. In addition to rail arrivals, there were 2,990 boxes of salmon and 852 boxes of halibut received from the Pacific coast on March 8 by steamer.

Carload arrivals of halibut and salmon at Boston during year ended September 30, 1922.

Month.	Carloads.	Month.	Carloads.
1921.		1922—Continued.	
October	18½	April	7
November	21	May	11
December	20	June	15
1922.		July	11½
January	13	August	15
February	8½	September	20½
March	[1] 8	Total	169

[1] Does not include 2,990 boxes frozen salmon, 542 boxes frozen halibut, and 310 boxes salmon received from Pacific coast by vessel on March 8.

WHOLESALERS' SUGGESTIONS ON MARKET EXPANSION.

Emphasis has previously been laid upon the fact that Boston's catch can quickly be increased 100 per cent, provided the product can be sold. Therefore, the enlargement of the present marketing area, together with increasing consumption in districts already buying, is the issue wherein lies the future of Boston's development as a fishing port. For this reason a personal canvass was made of all wholesale fish dealers, and their opinions were solicited as how best to increase the sale of their product in markets outside of Boston. The principal recommendations were as follows: (1) Reduction of express rates and improvement of service; (2) granting of special commodity rates on fish in car lots; (3) organized advertising; and (4) better handling methods and Federal inspection.

Agreement is prevalent that express rates are unreasonably excessive, while unreliable service rendered is the cause of universal complaint. Dealers are also emphatic in their denunciation of the present lack of definite delivery schedules, which they declare must be established and adhered to by transportation agencies. They assert, in addition, that special commodity rates are needed on car lots, such shipments to be labeled "Fish," and rushed as a perishable food. As a means of procuring cheaper express rates and commodity tariffs the wholesalers suggest united action by all local fish dealers in conjunction with trade and Federal organizations, that these issues may be forced to the attention of the Interstate Commerce Commission and remedied. Members of the trade express hope that by concerted action at points of destination consignees may be able to compel some concessions in the matter of definite delivery schedules.

A majority opinion exists that the thorough prosecution of a well-devised advertising campaign would prove very profitable. The wartime propaganda distributed by the United States Bureau of Fisheries is considered by many as having brought satisfactory results

both in increasing the sale of their product and in introducing it into new territory. Some wholesalers, however, consider that the most successful advertising scheme yet devised was that used by the Boston wholesale fish dealers' combine, which selected prospective marketing areas, sent representatives into these territories, and then supplied them with car lots of fish at a very low cost. By this method the public at distant points was given the opportunity of trying Boston fish at a fraction of the price that retailers in remote markets would have to obtain to cover overhead and the hazard of handling fish little known to the public. Certain of the larger dealers suggest that the numerous small companies now operating on the Fish Pier be organized into a few large combinations for the conduct of a more profitable business and the carrying out of an extensive advertising campaign through coordinated efforts.

Several firms urge a more conscientious adherence to principles conducive to better quality and service on the Boston Fish Pier by dealers themselves and advocate Federal supervision of landing and handling methods similar to present-day meat inspection. The combined recommendation of the trade to the Government, they believe, would doubtless inaugurate this work.

One wholesaler suggests the publication by the Government of directions for the proper dressing and cutting of fish, saying that improper methods of performing this work is the rule among retail merchants.

RETAILERS' SUGGESTIONS ON MARKET EXPANSION.

Individual interviews were obtained with all retail merchants handling fish every day in the week and constructive criticism asked as to how retail sales in Boston might be increased. Out of 163 firms called upon, 92 had no suggestions to offer, expressing themselves as of the opinion that poor prospect exists for increasing sales since Boston's fish-consuming population is largely Catholic and rarely purchases fish on any day other than Friday. The plans proposed by the remaining dealers are designed in general to work toward two well-defined improvements, namely, bettering of quality and extension of effort in fish advertising.

Dealers who consider that the business can best be benefited by an improvement in the quality of fish sold are of united opinion that at present the trade suffers greatly from a bad practice among one-day dealers. Cart peddlers, grocers, and other tradesmen who handle fish only on Friday have the practice of holding over unsold quantities until Monday, when, because these venders have no proper cold-storage facilities, purchasers receive a decidedly inferior product, causing the public to form the opinion that Friday is the only day in the week when good fish can be had. As a remedy, dealers urge the enforcement of legislation requiring cart peddlers and other lax venders to observe the same rules for storage and cleanliness now required of keepers of fish stores, that the public may not be prejudiced against marine foods by the unsightly spectacle of the modern peddler's cart. In this connection it is significant that the dealers handling the best quality obtainable state that they sell practically as much fish on one day as another and that fluctuations in price produce no discernible effect on sales.

As an index of the demand that it is expected would develop, were quality improved, attention is directed to the fact that shore haddock, landed only a few hours after being caught, enjoys an eager demand at twice the price of offshore haddock, the retailers arriving in numbers as early as 4.30 in the morning in order to obtain these fish. Several dealers believe that what is most needed is shorter offshore trips, so that the catch will be landed in better condition, and combined with this they advocate State inspection at piers where fish are landed as assurance of quality.

A large number of retail dealers advocate that fish cookery demonstration work be inaugurated in Boston to acquaint housewives with the best ways of preparing, cooking, and serving fish. Repeated suggestions were also made by these same dealers that various other advertising mediums should be employed in conjunction with fish cookery demonstrations. The common recognition that more attention should be given to increased fish publicity finds expression in varied propositions for attaining this end, among which is the use of attractive road signs, street-car ads, window placards, the distribubution of cooking recipes, and the regular use of newspaper space.

It is insisted that more attention must be directed toward improvement in methods of dressing and cutting fish. Specific recommendations are that fins be entirely cut out of the fish, since, in cooking, these impart a taint to the flesh; that fish be scrupulously cleaned of gurry, as otherwise this waste penetrates and pollutes the ice used in cooling and produces an objectionable odor; that reckless filleting be stopped, so that the choice flesh of the fish lying next the backbone will no longer be lost.

RETAIL DISPLAY.

Of the 171 dealers retailing fresh fish each day in tne week, 145 exhibited their product and 26 kept their supply in ice chests that were entirely closed except for the occasional instance of a glass cover. Of those who exhibited, 33 made both window and interior displays, 86 used window displays only, and 26 displayed their fish solely within the shops. Of the 119 establishments using window displays, 41 showed the fish on porcelain plates placed on tile, 16 arranged the fish on tile surfaces, 35 had metal-topped tables, 12 used wooden equipment, 7 placed porcelain pans on metal tables, 5 used only pans, and 3 set the fish on wood. Of the 59 firms having interior displays, 24 exhibited the fish in enameled ware ranged upon tile counters, 9 on tile tables, 12 on metal-topped tables, 6 in pans alone, 4 in pans on metal, 2 in pans on wood, and 2 on wood. Garnishments of lettuce leaves, parsley, radishes, or other greens were present in 12 houses, and 48 protected their displays with glass covers.

BOSTON ORDINANCES GOVERNING SALE OF FISH.

Chapter 40, Section 1. No person * * * shall have in his possession, with intent to sell, fish of any kind, except flounders, smelts, and other small fish, salmon, and shad, until the same have been cleaned of their entrails and other refuse parts, or fish of any kind unless they are kept in covered stalls or fish-boxes or covered carts, which shall be clean and in good order and well secured from the rays of the sun.

Sec. 119, Par. 1. All drip or overflow pipes shall be extended to some place in open sight, and in no case shall any such pipe be connected directly with the drain pipe. No waste pipe from a refrigerator or other receptacle in which provisions are stored shall be connected directly with a drain or other waste pipe.

DIRECTORY OF BOSTON DEALERS IN FRESH SEA FOOD.

In Boston there are 108 firms conducting a wholesale business in fresh and frozen fishery products. Fresh fish are handled by 87 of these establishments, frozen fish by 85, oysters by 66, other shellfish by 81, salted fish by 59, smoked fish by 61, canned fish by 10, fresh-water fish by 3, poultry by 2, and meats by 2.

Retail dealers handling fish every day in the week number 171, of whom 170 handle fresh fish, 134 frozen fish, 138 oysters, 136 other shellfish, 141 salted fish, 145 smoked fish, 89 canned fish, 32 fresh-water fish, 36 poultry, 38 meats, 60 vegetables, 33 groceries, and 7 delicacies.

Directory of Boston dealers in fresh sea food.

[The following are the symbols in table: C=Commission; J=Jobber; P=Producer.]

Dealers.	Fish handled.								Other goods.		Symbols.
	Fresh	Frozen.	Oysters.	Other shellfish.	Salted.	Smoked.	Canned.	Fresh-water fish.	Poultry.	Meats.	
WHOLESALE ONLY.											
Adams Co., J., 23 Fish Pier	×	×	×	×		×					J.
Arnold & Windsor Co., 14 Fish Pier	×	×	×	×	×	×					J, C.
Atlantic Crab Meat Co., 71 Commercial Wharf				×[1]							
Atlantic Fish Co., 132 Atlantic Ave	×	×						×			J.
Atlantic Halibut Co., 28 Fish Pier	×	×									J, C.
Atlantic & Pacific Fish Co., 21 Fish Pier	×	×	×	×	×	×					J.
Atlas Fish Co., 39 Fish Pier	×	×	×	×	×	×					J.
Atwood & Co., 31 Fish Pier	×	×									C.
Atwood Co., D., 246 Northern Ave			×	×							J.
Atwood Co., H. O., 252 Northern Ave			×	×							J.
Baker, A. G., 1 Fish Pier	×	×	×	×	×	×					J.
Baker, A. L., 77 Commercial Wharf				×[1]							
Baker, Boies & Watson, 36 Fish Pier	×	×	×	×	×	×					J, C, P.
Batchelder & Snyder, 47–63 Blackstone St	×	×	×	×	×	×			×	×	J.
Bay Fish Co., 8 Fish Pier	×	×	×	×	×	×					J.
Bay State Fishing Co., 30 Fish Pier	×	×				×					P, J.
Bay State Lobster Co., 272 Northern Ave				×[2]							J.
Best Fish Co., 15 Fish Pier	×	×	×	×	×	×					J.
Booth Fisheries Co., 33 Fish Pier	×	×	×	×	×	×					J.
Boston Fish Co., 18 Fish Pier	×	×			×	×					J, C.
Burns & McKeon, 32 Fish Pier	×	×	×	×	×	×					J, C.
Bussalacchi Bros., 262 Northern Ave	×	×	×								J. P.
Bussalacchi, T. & J., 270 Northern Ave	×	×									J.
Cape Fish Co., 42 Fish Pier	×	×	×	×	×	×					J.
Cefalu, Joseph, 144 Atlantic Ave	×	×	×	×							J.
Coleman, Son Co., 38 Fish Pier	×	×	×	×	×	×					J.
Colonial Fisheries (Ltd.), 19 Administration Bldg.	×	×									C, J.
Consolidated Lobster Co., 280 Northern Ave				×[2]							J.
Consolidated Wier Co., 31 Fish Pier	×	×									P, J
Corse & Cannizzo, 112 Atlantic Ave	×	×			×	×					
Cox, John G., 274 Northern Ave				×[2]							J.
Crocker & Windsor, 10 Administration Building	×	×	×	×	×	×	×				J, C.
Delahoyde Bros., 118 Atlantic Ave	×	×	×	×							J.
Dench & Hardy, 25 Administration Bldg	×	×			×	×					J, C.
Fitch, Warren Co., 24 Fish Pier	×	×	×	×	×	×					J, C.
Freeman & Cobb Co., 31 Fish Pier	×	×									J.
Fulham & Herbert, 12 Fish Pier	×	×	×	×	×	×					J, C.
Gardner, J. N., 9 Administration Bldg	×			×	×						C.
Globe Fish Co., 134 Atlantic Ave	×	×	×	×	×	×					J.
Gloucester Fresh Fish Co., 19 Fish Pier	×	×	×	×	×	×					J.
Goodspeed Co., L. B., 25 Fish Pier	×	×	×	×	×	×					J.
Green, Louis H., Administration Bldg	×	×									C.
Haley, Austin, 10 Long Wharf	×	×	×	×	×	×					C.
Hamilton Co., R. S., 17 Administration Bldg	×	×	×	×	×	×					J, C.
Hammond Co., J. W., 15 Northern Ave				×							J.
Harding, F. E., 16 Fish Pier	×	×	×	×		×					J.

[1] Crab meat only.

[2] Lobsters only.

Directory of Boston dealers in fresh sea food—Continued.

Dealers.	Fish handled.								Other goods.		Symbols.
	Fresh.	Frozen.	Oysters.	Other shellfish.	Salted.	Smoked.	Canned.	Fresh-water fish.	Poultry.	Meats.	
WHOLESALE ONLY—continued.											
Hasking Fish Co., 26 Fish Pier	×	×	×	×	×	×	....	....	....	....	J, C.
Healy & Lyon, 6 Administration Bldg	×	×	×	×	×	×	....	....	....	....	J, C.
Henry & Close, 20 Fish Pier	×	×	×	×	....	×	....	....	....	....	J.
Higgins Co., R. R., 254 Northern Ave	....	....	×	×	....	....	....	....	....	....	J.
Higgins Co., R. R., 144 Atlantic Ave	....	....	×	×	....	....	....	....	....	....	J.
Hunt & Co., C., 17 Fish Pier	×	×	....	....	....	....	....	....	....	....	C, J.
Ingalls Co., George M., 5 Fish Pier	×	×	×	×	×	×	×	....	....	....	J.
Interstate Fish Corporation, 8 Administration Bldg	×	×	×	....	×	....	....	....	....	....	C.
Johnson & Young, 73 Commercial Wharf	....	....	....	×	....	....	....	....	....	....	J.
Kelley Co., R. M., 12 Administration Bldg	×	×	×	×	×	×	....	....	....	....	C.
Lewis & Co., A. J., 96 Commerce St	×	×	×	×	×	×	....	....	....	....	J.
Malone, E. A., 195 Atlantic Ave	×	....	....	×	×	....	....	....	....	....	C.
Mantia & Sons, John, 268 Northern Ave	×	×	×	×	....	....	....	....	....	....	J.
Mantia & Co., S., 124 Atlantic Ave	×	×	×	×	×	....	....	....	....	....	J.
Massachusetts Lobster Co., 150 Northern Ave	....	....	....	×	....	....	....	....	....	....	J.
McGinn Lobster Co., H., 278 Northern Ave	....	....	....	×[2]	....	....	....	....	....	....	J.
McLoon & Co., A. C., 250 Northern Ave	....	....	....	×	....	....	....	....	....	....	J.
Nagle Co., John, 3 Administration Bldg	×	×	×	×	×	....	....	....	....	....	C.
National Fish Co., 126 Atlantic Ave	×	×	....	....	....	....	....	×	....	....	J.
Neal Co., John R., 30 Fish Pier	×	×	....	....	....	×	....	....	....	....	J.
New England Fish Co., 44 Fish Pier	×	×	....	....	....	....	....	....	....	....	J.
Obrien & Co., R., 34 Fish Pier	×	×	....	....	....	....	....	....	....	....	J.
Ocean Fish Corporation, 6 Fish Pier	×	×	....	....	×	×	....	....	....	....	J.
O'Hara Bros., 22 Fish Pier	×	×	×	×	×	×	....	....	....	....	P, C, J.
O'Hara & Co., F. J., 13 Fish Pier	×	×	×	×	×	×	....	....	....	....	J.
Parker Fish Co., 140 Atlantic Ave	×	×	×	×	....	×	....	....	....	....	J.
Phillips & Co., B. F., 27 Fish Pier	×	×	×	×	×	×	....	....	....	....	J.
Pier Fish Co., 130 Atlantic Ave	×	×	×	×	....	....	....	....	....	....	J.
Prime Fish Co., 138 Atlantic Ave	×	×	×	×	×	×	....	....	....	....	J.
Prior & Mahoney, 24 Administration Bldg	×	×	....	....	×	×	....	....	....	....	C.
Prior Co., P. H., 29 Fish Pier	×	×	×	×	×	×	....	....	....	....	J.
Putnam & Son, Henry, 278 Northern Ave	....	....	....	×[2]	....	....	....	....	....	....	J.
Rich & Co., A. F., 2 Fish Pier	×	×	....	....	×	....	....	....	....	....	J, I.
Rich Co., E. A., 4 Fish Pier	×	×	×	×	....	×	....	....	....	....	J.
Rich Co., H. A., 11 Fish Pier	×	×	×	×	×	×	....	....	....	....	J.
Rich & Co., John W., 4 Administration Bldg	×	×	....	....	×	×	....	....	....	....	C.
Rich, Joseph A., 11 Administration Bldg	×	×	×	×	×	×	....	....	....	....	C.
Russo & Sons, 126 Atlantic Ave	×	×	×	×	×	×	....	....	....	....	J.
Shattuck & Jones, 154 Atlantic Ave	×	×	×	×	×	×	×	....	....	....	J.
Shore Fish Co., 37 Fish Pier	×	×	×	×	×	×	....	....	....	....	J.
Smith & Son, Jay C., 42 Lewis Wharf	....	....	....	×	....	....	....	....	....	....	J.
Snow & Parker, 41 Fish Pier	×	×	....	....	....	....	....	....	....	....	J, C, P.
Standard Fish Co., 146 Atlantic Ave	×	×	....	....	....	....	....	×	....	....	J.
Star Fish Co., 22 Fish Pier	×	×	×	×	×	×	....	....	....	....	P, C, J.
Story & Simmons Co., 10 Fish Pier	×	×	×	×	×	×	....	....	....	....	J, C.
Stubbs, J. A., 244 Northern Ave	....	....	×	×	....	....	....	....	....	....	J.
T Wharf Fish Co., 152 Atlantic Ave	×	×	×	×	×	×	....	....	....	....	J.
Taylor & Mayo, 3 Fish Pier	×	×	×	×	×	×	....	....	....	....	J.
Thorndike & Hix Lobster Co., 260 Northern Ave	....	....	....	×	....	....	....	....	....	....	J.
Union Lobster Co., 60 Eastern Ave	....	....	....	×	....	....	....	....	....	....	J.
Whitman, Ward, & Lee Co., 9 Fish Pier	×	×	×	×	×	×	×	....	....	....	J.
Wright & Willis, 258 Northern Ave	....	....	×	×	....	....	....	....	....	....	J.
Young & Co., J. A., 79 Commercial Wharf	....	....	....	×	....	....	....	....	....	....	J.
Zizzo, F. & L., 116 Atlantic Ave	×	×	....	....	....	....	....	....	....	....	J.
WHOLESALE AND RETAIL.											
Atwood, Simeon, 66 Beach St	×	×	×	×	×	×	×	....	....	....	
Foley, Mike, 3 Friend St	×	×	×	×	×	×	×	....	×	....	
Johnson, F. H., 114 Faneuil Hall Market	×	×	×	×	×	×	×	....	....	....	
Johnson, Marshall, & Son, 26 Faneuil Hall Square	×	×	×	×	×	×	×	....	....	....	
Litchfield, H. S., 105 Summer St	×	×	×	×	×	×	....	....	....	....	
Previor, P. P., 30 Spring St	×	×	....	....	....	×	....	....	....	×	
Prior & Townsend, 127 Faneuil Hall	×	×	×	×	×	×	×	....	....	....	
Rich & Matthews, 115 Faneuil Hall	×	×	×	×	×	×	×	....	....	....	

[2] Lobsters only.

Directory of Boston dealers in fresh sea food—Continued.

Dealers.	Fish handled.								Other goods.				
	Fresh.	Frozen.	Oysters.	Other shell-fish.	Salted.	Smoked.	Canned.	Fresh-water fish.	Poultry.	Meats.	Vegetables.	Groceries.	Delicates-sen.
RETAIL ONLY.													
Adams Market, 160 Harvard Ave	×	×	×	×	×	×	×	....	×	×	×	×	....
Adduce Bros., 226 Bowdoin St	×	×	×	×	×	×	×	....	×	×	×	×	....
Albee, Samuel, 65 Fairmont Ave	×	×	×	×	×	×	×	....	....	....	....	....	....
Alger, F. J., 1403 Washington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Alston Public Market, 103 Brighton Ave	×	×	×	×	×	×	×	....	×	×	×	×	×
Anderson, 324 Bowdoin St	×	×	×	×	×	×	×	....	×	×	×	×	....
Arborway Fish Market, 41 Hyde Park Ave	×	....	×	×	×	×	×	....	....	....	×	....	....
Augustin, Shoulla, 78 Cottage St	×	×	×	×	....	....	....	....	....	....	....	....	....
Avenue Fish Market, 1121 Bluehill Ave	×	×	....	....	×	....	....	....	....	....	×	....	....
Baket, T. D., 769 Washington St	×	×	×	×	×	×	×	....	×	×	×	×	×
Barber, W. A., 44 Paris St	×	....	×	×	×	×	×	....	....	....	....	....	....
Barons Fish Market, 1080 Bluehill Ave	×	×	....	....	....	....	....	×	....	....	×	....	....
Barry Greves Co., 10 Roxbury St	×	×	×	×	×	×	×	....	....	....	....	....	....
Bassett, J., 60 Spring St	×	....	....	....	....	....	....	×	....	....	....	....	....
Bayside Fish Market, 1090 Dorchester Ave	×	×	×	×	×	×	....	....	....	....	....	....	....
Beak & McGlauflin, 169 Warren St	×	×	×	×	×	×	....	....	×	×	×	×	....
Bearse, Horace K., 323 Centre St	×	×	×	×	×	×	×	....	....	....	....	....	....
Belgrade Fish Market, 182 Belgrade Ave	×	×	×	×	×	×	....	....	....	....	....	....	....
Bello, Louis, 1058 Bluehill Ave	×	....	....	....	....	....	....	×	....	....	×	....	....
Bennington Fish Market, 100 Bennington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Bentley, R. L., 1657 Bluehill Ave	×	....	×	×	×	....	×	×	×	×	....	....	....
Berenson, B., 311 Bluehill Ave	×	....	....	....	....	....	....	×	....	....	....	....	....
Berger Fish Market, 95 Erie St	×	....	....	....	....	....	....	×	....	....	....	....	....
Berry, L. W., 1141 Columbus Ave	×	×	×	×	×	....	×	....	×	×	×	×	....
Blake & Gillispi, 1897 Dorchester Ave	×	....	×	×	×	×	×	....	....	....	×	×	....
Bromberger, Nathaniel, 334 Tremont St	×	×	×	×	×	×	×	....	....	....	....	....	....
Brondy, H., 174 Harvard Ave	×	×	×	×	×	×	×	....	×	×	×	×	....
Brown, C. H., 1516 Dorchester Ave	×	×	×	×	×	×	×	....	×	×	×	×	....
Brown, Henry F., 23 Oak St	×	×	×	×	×	×	....	....	....	....	....	....	....
Brunswick, R., 59 Salem St	×	×	....	....	....	....	....	×	....	....	....	....	....
Busalacchi Bros., 308 Harrison St	×	×	×	×	×	×	....	×	....	....	....	....	....
Calven, E. C., 1985 Washington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Cann. R. C., 122 Canal St	×	×	×	×	×	×	....	....	....	....	....	....	....
Cannizzo, B., 168 North St	×	×	....	....	....	....	....	....	....	....	....	×	....
Carey, E. F., 310 Dorchester Ave	×	×	×	×	×	×	×	....	....	....	×	×	....
Cashman, M. J., 99 Chelsea St	×	×	×	×	×	×	×	....	....	....	....	....	....
Catalanotti & Son, 164 North St	×	×	....	....	....	....	....	....	....	....	....	....	....
Catanize, J., 133½ North St	×	×	×	×	....	....	....	....	....	....	....	....	....
Coffey, J. F., 493 Dudley St	×	×	×	×	×	×	....	....	....	....	×	....	....
Coffin, Jos., 653 Warren St	×	×	×	×	×	×	×	×	....	....	....	....	....
Cohen, Hyman L., 48 Phillips St	×	×	....	....	×	×	×	×	....	....	....	....	....
Colleran, F. A., 2716 Washington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Crosby, T., 97 Main St	×	×	×	×	×	×	....	....	....	....	....	....	....
Cushner, H., 352 Harrison St	×	×	....	....	....	×	....	×	....	....	....	....	....
Deion, R., 203 Main St	×	....	×	×	×	×	×	....	....	....	....	....	....
Dennis Fish Market, 145 Emerson St	×	×	×	×	×	×	....	....	....	....	....	....	....
Dock Square Fish Market, 21½ Faneuil Hall Square	×	×	×	×	×	×	....	....	....	....	....	....	....
Dolan's Cash Market, 1627 Bluehill Ave	×	....	×	×	×	×	×	....	×	×	×	....	....
Dolbeare Market, 759 Dudley St	×	×	×	×	×	×	....	....	....	....	....	....	....
Dorr, Arthur, 132 Canal St	×	×	×	×	×	×	×	....	×	×	×	....	....
Dorr, Arthur, 2 North St	×	×	×	×	×	×	×	....	×	×	×	....	....
Dorr, Arthur, 587 Washington St	×	×	×	×	×	×	×	....	×	×	×	....	....
Dorr, Arthur, 380 Hancock St	×	×	×	×	×	×	×	....	....	....	....	....	....
Eagle Fish Market, 249 Dudley St	×	×	×	×	×	×	×	....	....	....	....	....	....
Eicorn Fish Market, 163 Warren St	×	×	×	×	×	×	....	....	....	....	....	....	....
Eli, Ernest, 1135 Bluehill Ave	×	×	....	....	×	×	....	×	....	....	×	....	....
Elliott Square Fish Market, Elliott Square	×	×	×	×	×	×	×	....	....	....	....	....	....
Elmore Fish Market, 2778 Washington St	×	....	×	×	×	×	....	....	....	....	×	....	....
Ereka Fish Market, 90 Brook St	×	×	×	×	×	×	....	....	....	....	....	....	....
Faber, J. T., 135 Lexington St	×	×	×	×	×	×	×	....	....	....	....	....	....
Fandrey, John W., 135 Norfolk St	×	×	×	×	×	×	×	....	....	....	....	....	....
Farm & Sea Food Shop, 570 Dudley St	×	×	×	×	×	×	....	....	....	....	×	....	....
Farmers Market, 213 Bowdoin St	×	×	×	×	×	×	....	....	....	....	×	....	....
Ferdinands, J. W., 1463 Tremont St	×	×	×	×	×	×	×	....	....	....	....	×	....
Ferquest, F. O., 149 Main St	×	×	×	×	×	×	×	....	×	×	×	×	....
Finlay, W. R., 169 Neponset Ave	×	×	×	×	×	×	×	....	....	....	....	....	....
Foley, R., 213 Elliott St	×	×	×	×	×	×	×	....	....	....	....	....	....
Folsom, B., 1805 Washington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Fowels, A. A., 309 Meridian St	×	×	×	×	×	×	....	....	....	....	....	....	....
Frankland Fish Market, 138 Broad St	×	×	×	×	×	×	....	....	....	....	....	....	....
Frisby, W. T., 207 Cambridge St	×	×	×	×	×	×	×	....	....	....	....	....	....
Gafney & Pennin, 1690 Dorchester Ave	×	×	×	×	×	×	....	....	....	....	×	....	....

Directory of Boston dealers in fresh sea food—Continued.

Dealers.	Fish handled.								Other goods.				
	Fresh.	Frozen.	Oysters.	Other shellfish.	Salted.	Smoked.	Canned.	Fresh-water fish.	Poultry.	Meats.	Vegetables.	Groceries.	Delicatessen.
RETAIL ONLY—continued.													
Gallant, M., 326 Harrison St	×	×	...	...	...	×	...	×	...	...	...	...	...
Garabedion, Al., 289 Main St	×	×	×	×	×	×	×	...	...	...	×	...	...
Gloucester Fish Ship, 66 Dundee St	×	...	×	×	×	×	×	...	×	×	×	×	...
Goldberg, M., 1384 Dorchester Ave	×	×	×	×	×	×	×	...	...	...	×	...	...
Goldblatt, J., 39 Spring St	×	...	...	...	...	...	...	×	×	...	...	...	...
Goldstein, B., 271 Bluehill Ave	×	×	...	...	×	×	...	×	...	×	...	...	...
Goldstein, H. M., 37 Salem St	×	×	...	...	×	×	×	×	...	...	...	×	...
Goldstein, M. M., 357 Bluehill Ave	×	...	...	...	...	...	...	×	...	...	...	...	...
Goldstein, S., 65 Salem St	×	...	...	...	×	×	×	×	...	...	...	×	...
Gorewitz, L., 1118 Bluehill Ave	×	...	...	...	...	...	...	×	...	...	×	...	...
Gove & Mollins, 156 Federal St	×	×	×	×	×	×	×	...	...	...	...	...	...
Guiffre & Son, 147 North St	×	...	...	...	...	...	...	...	...	...	...	...	...
Hart, James, 24 Hyde Park Ave	×	×	×	...	×	×	×	...	...	...	×	...	...
Helfand, Harry, 47 Salem St	×	×	×	×	...	...	...	×	...	...	...	...	...
Henderson Fish Market, 755 Centre St	×	×	×	×	×	×	...	...	...	...	...	...	...
Hogan, D. J., 1577 Tremont St	×	×	×	×	×	×	×	...	...	...	...	...	...
Horne, H. P., 266 Friend St	×	×	×	×	×	×	×	...	...	...	...	...	...
Hutchison, W. K., 284 Massachusetts Ave	×	×	×	×	×	×	...	...	×	×	×	×	...
Hyde Park Fish Market, 1282 Hyde Park Ave.	×	×	×	×	×	×	×	...	×	×	...	...	...
Hyde Park Public Market, 1260 Hyde Park Ave.	×	×	×	×	×	×	×	...	×	×	...	...	...
Isenberg, R., 28 Spring St	×	×	...	...	...	×	...	×	...	×	...	...	...
Jackson, G. D., 64 Anderson St	×	...	×	×	×	×	...	...	...	...	...	...	...
Johnson, S. C., 632 Tremont St	×	×	×	×	×	×	...	...	...	...	...	...	...
Kane, H. T. & J. E., 96 Staniford St	...	...	×	×	...	...	...	...	...	...	...	...	...
Karlsberg, M., 78 Erie St	×	×	...	...	...	...	...	×	...	...	×	...	...
Kent Fish Market, 3116 Washington St	×	×	×	×	×	×	×	...	...	...	...	...	...
King Fish Market, 113-B Warren St	×	×	×	×	×	×	×	...	...	...	...	...	...
Lalley's Fish Market, 69-A L Street	×	×	×	×	×	×	×	...	...	...	...	...	...
Lenane, J. J., 41 Dearborn St	×	×	×	×	×	×	...	...	...	...	×	...	...
Leonard Bros., 1096 Boylston St	×	×	×	×	×	×	×	...	×	×	×	...	...
Longfellow, H. W., 6 Franklin St	×	×	×	×	×	×	×	...	×	×	×	...	...
Lynn Bros., 1342 Bluehill Ave	×	...	×	×	×	×	×	...	...	...	...	...	...
Mahoney, D., 1846 Dorchester Ave	×	...	×	×	×	×	×	...	...	...	×	...	...
Marden, G. F., 315 Washington St	×	...	×	×	×	×	...	...	...	...	...	...	...
Maywood Fish Market, 367 Warren St	×	×	×	×	×	×	×	×	...	...	...	...	...
McDonald's Fish Market, 383 Centre St	×	×	×	×	×	×	×	...	...	...	...	...	...
McFarland, J., 358 Bowdoin St	×	×	×	×	×	×	×	...	...	...	×	...	...
Mendel's Fish Market, 1062 Bluehill Ave	×	...	...	...	...	×	...	×	...	...	×	...	...
Mickleson, S	×	×	...	...	...	×	...	×	...	...	×	...	...
Milton Fish Market, 2261 Dorchester Ave	×	×	×	×	×	×	...	...	...	...	...	...	...
Mohican Market, 96 Washington St	×	×	×	×	×	×	×	...	×	×	×	×	×
Mohican Market, 2152 Washington St	×	×	×	×	×	×	×	...	×	×	×	×	×
Mohican Market, 423 Broadway	×	×	×	×	×	×	×	...	×	×	×	×	×
Morgan's Fish Market, Eagleston Square	×	×	×	×	×	×	×	...	...	...	...	...	...
Morris, J., 1920 Centre St	×	...	×	×	×	×	...	...	...	...	...	...	...
Morse, D. J., 179 Shawmut Ave	×	×	×	×	×	×	...	...	...	...	...	...	...
Nahant Fish Market, 152 Summer St	×	×	×	×	×	×	×	...	...	...	...	...	...
Nally, Marshall, 181 Green St	×	×	×	×	×	×	×	...	...	...	...	...	...
National Butchers, 537 Columbia Road	×	...	×	×	×	×	...	...	×	×	...	...	...
National Butchers, 187 Harvard St	×	...	×	×	×	×	×	...	×	×	...	...	...
Newton Street Fish Market, 189 West Newton St	×	×	×	×	×	×	×	...	...	...	...	×	...
Norfolk Cash Market, 130 Norfolk St	×	×	×	×	×	×	...	...	...	...	×	×	×
Ober, J. I., 73 Salem St	×	×	×	...	×	×	...	...	...	×	...	...	...
Ocean Fish Market, 352 Washington St	×	×	×	×	×	×	×	...	...	...	...	×	...
Paine & Kiddig, 34 Charles St	×	...	×	×	×	×	×	...	...	...	...	...	...
Perezza, J., 174 North St	×	...	...	...	...	...	...	...	...	...	...	...	...
Perry's Fish Market, 667 Broadway	×	×	×	×	×	×	...	...	...	...	...	...	...
Prescott's Market, 19 Poplar St	×	×	×	×	×	×	...	...	...	...	...	...	...
Previor, Charles, 307-A Bluehill Ave	×	×	...	...	...	...	...	×	...	...	...	...	...
Previor, Frank, 1106 Bluehill Ave	×	...	...	...	...	×	...	×	...	...	×	...	...
Ralph Bros., 25 Massachusetts Ave	×	...	×	×	×	×	×	...	×	×	×	×	×
Rawson Fish Market, 171 Summer St	×	×	×	×	×	×	×	...	×	×	×	...	...
Reenfield Cash Market, 1707 Dorchester Ave	×	...	×	×	×	×	×	...	×	×	×	×	...
Rhodes Bros., 170 Massachusetts Ave	×	×	×	×	×	×	×	...	×	×	×	×	...
Riverside Fish Market, 7 South Huntington Ave	×	...	×	×	×	×	×	...	...	...	...	...	...
Rosenberg, J., 142 Humboldt Ave	×	×	...	...	×	×	×	×	...	...	...	...	...
Rugg & Litchfield, 108 Blackstone St	×	×	×	×	×	×	...	...	...	...	...	...	...
Sardina, J., 121 North St	×	...	...	...	...	...	...	...	...	...	...	...	...
Savage, E. L., 234½ Bunker Hill St	×	×	×	×	×	×	...	...	...	...	...	...	...
Shattuck & Jones, 128 Faneuil Hall Market	×	×	×	×	×	×	×	...	...	...	...	...	...

Directory of Boston dealers in fresh sea food—Continued.

Dealers.	Fish handled.								Other goods.				
	Fresh.	Frozen.	Oysters.	Other shell-fish.	Salted.	Smoked.	Canned.	Fresh-water fish.	Poultry.	Meats.	Vegetables.	Groceries.	Delicatessen.
RETAIL ONLY—continued.													
Sherman, Isaac, 1152 Bluehill Ave	×	....	....	....	....	....	....	×	....	....	×	....	....
Silva, F., 1999 Washington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Snapp, H., 290 Main St	×	×	×	×	×	×	....	....	×	×	×	×	....
Stodder, George F., 174 Friend St	×	×	×	×	×	×	....	....	....	....	....	....	....
Strong, C. J., 65 Bunker Hill St	×	×	×	×	×	×	×	....	....	....	×	....	....
Sullivan, C., 1059 Dorchester Ave	×	×	×	×	×	×	×	....	....	....	×	....	....
Sullivan Fish Market, 144-A South St	×	×	×	×	×	×	....	....	....	....	....	....	....
Sweet, A., 227 Bowdoin St	×	×	×	×	×	×	....	....	....	....	....	....	....
Tabrisky, D., 372 Bluehill Ave	×	....	....	....	....	....	....	×	....	....	×	×	....
Transfer Market, 94 Harvard St	×	×	×	×	×	×	×	....	×	×	×	×	....
United Butchers, 587 Columbus Ave	×	×	×	×	×	×	×	....	×	×	×	×	....
Uphams Corner Market, Uphams Corner	×	×	×	×	×	×	×	....	×	×	×	×	....
Vargus, Joseph, 633-A Bennington St	×	×	×	×	×	×	....	....	....	....	....	....	....
Vizzers, E., 1502-A Dorchester Ave	×	....	×	×	×	×	....	....	....	....	....	....	....
Wade, R. L., 1353 Washington St	×	×	×	×	×	×	×	....	....	....	....	....	....
Weinstein & Son, J., 160 Washington St	×	×	×	....	×	×	....	×	....	....	×	×	....
Welch, Mike, 54 Charles St	×	....	×	×	×	×	×	....	....	....	....	....	....
Weshnow, J., 1184 Bluehill Ave	×	×	....	....	....	....	....	×	....	....	×	....	....
Wood, D. G., 113 Green St	×	....	×	×	×	×	×	....	....	....	....	....	....
Woods, J. H., 955 Dorchester Ave	×	×	×	×	×	×	×	....	....	....	×	....	....
Young, T. E., 105 Dorchester Ave	×	×	×	×	×	×	×	....	....	....	....	....	....

PROPAGATION AND DISTRIBUTION OF FOOD FISHES, 1922.

REPORT OF THE DIVISION OF FISH CULTURE FOR THE FISCAL YEAR 1922.[1]

By GLEN C. LEACH, *Assistant in Charge of Fish Culture.*

CONTENTS.

[1] Appendix XVII to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 941.

INTRODUCTION.

An interesting point in connection with the bureau's fish-cultural activities, and one that augers well for future progress, is the intelligent interest displayed by an ever-increasing number of persons. State officials, persons interested in the commercial fisheries, sportsmen's organizations, officials of the large railroad companies, and many individuals in all parts of the country watch the work with jealous interest, as is made manifest by their frequent comment upon it. Such comments are sometimes commendatory in character, or they may take the form of adverse criticism. In either case they are welcomed as being indicative of an awakening public sentiment

and as a potent factor in stimulating those who are connected with fish culture to continued and greater effort for the advancement of the work.

VALUE OF FISHES OF MINOR INTERIOR WATERS.

It has long been recognized that the commercial fisheries of the country have constituted one of our most valuable national assets, but it is only recently that the fishes of our minor interior waters have come to be considered by the general public as a resource of consequence. The wild life of both land and water is now very generally regarded as a great national asset, so much so that the so-called game birds and other land animals have within recent years been made the subject not only of Federal and State legislation but of international treaty as well. Though perhaps of equal importance, fish have not received the same attention, notwithstanding the fact that the Federal Government has long maintained fish-cultural stations at suitable points in various parts of the country. The monetary value of our commercial fisheries is known with some degree of accuracy from statistics that may be compiled without unusual difficulty. On the other hand, the value of the fishes of inland waters that do not figure in a commercial sense must be based on estimate, owing to the difficulty encountered in securing accurate data. However, enough is known to warrant the statement that the compilation of such data would present an imposing array of figures whose total would be surprisingly large. In support of this statement, the following estimates of the value of fish taken by anglers in three of the States bordering the Great Lakes are of interest. The figures are quoted from an address by the fish commissioner of Minnesota at Milwaukee, in March, 1922. The figures are intended to cover only the actual value of the fish taken by anglers and do not include any value the fish may have had as an incentive to travel, recreation, or indirect worth of any kind; nor do they include any estimate of the amounts contributed by tourists and anglers to the volume of business of railways, hotels, outfitters, and others. It is assumed by the Bureau of Fisheries that the high value placed on this estimated catch is based on retail prices.

Value of fish taken by anglers.

State.	Pounds.	Value.
Wisconsin, 1921	....	$2,125,000
Minnesota, 1921	7,000,000	3,000,000
Michigan, 1920	2,850,000	1,275,000

The States mentioned are in no wise exceptional in this respect, as the figures presented could be duplicated or even exceeded in other sections of the country. The American public is rapidly acquiring the habit of outing vacations by motor, with a consequent increase in the demand for good fishing in inland waters. To meet this demand, an extension either by the States or the Federal Government of that branch of fish culture dealing with minor interior waters is imperative. Ever since practical fish culture was initiated

by the Federal Government the commercial fishes have received first consideration, and for many years more than 90 per cent of the output of the Federal hatcheries has consisted of such species as are prominent in the great commercial industry, and a large percentage of the funds available for fish culture has been devoted to this part of the work. The wisdom of this policy is not questioned, and there are many opportunities for the continued extension of the bureau's usefulness in this direction. Nevertheless, the time is at hand when the importance of maintaining the fish supply in our minor interior waters can not be overlooked, and any plans for the future extension of our fish-cultural activities must be comprehensive enough to include them.

COOPERATION WITH STATES, OTHER FEDERAL AGENCIES, AND FOREIGN GOVERNMENTS.

Each year there is to be noted an increasing amount of work along fish-cultural lines accomplished in cooperation with the various States. It has long been the policy of the bureau to foster and encourage such cooperation, and the results attained are gratifying. The fiscal year 1922 has found the bureau working in close harmony with 31 States that have thus far taken an active interest in practical fish culture. Such cooperative work has been varied in its nature, involving in some instances joint operations at egg-collecting stations and frequent exchange of eggs of various species for the convenient distribution of the resulting fish.[2] In other cases the bureau has loaned its distribution cars to enable the States quickly and economically to distribute the fish from their hatcheries, the State paying all transportation costs. In still other instances the bureau has been able to incubate in its hatcheries fish eggs purchased or otherwise acquired by States not operating hatcheries, the resulting fry or fingerlings being placed at the disposal of the State officers.

It sometimes happens that the bureau is unable to honor applications received, because it lacks funds for transporting fish to places remote from the points of production. Several States are now paying transportation charges for the bureau's cars to and from the point of production while engaged in distributing fish within their boundaries. In still another instance an agreement has been reached with the fishery authorities of a State whereby the State, as concerns the distribution of fish, has been divided into two parts. Under this agreement all applications for fish emanating north of the dividing line are to be honored by the State, while those from the southern portion are to be taken care of by the bureau. In theory at least this arrangement should result in greater economy and obviate the present duplication of effort.

It is desired to express special appreciation of the courtesies extended by the States of Washington and Oregon, whereby several items of work in which the bureau was interested were carried to

[2] A statement of the numbers and species of fish and fish eggs furnished to States and insular possessions of the United States during the fiscal year 1922 is contained on p. 84.

a point that would have been quite unattainable without such assistance. The bureau is indebted to the State of Montana for its liberal assistance in stocking streams and lakes in the Glacier National Park, Yellowstone National Park, and other waters of that region; to the State of Michigan for supplying considerable numbers of brook trout, rainbow trout, and grayling; and to the State of Maine for assistance rendered in connection with the landlocked salmon work in that State.

The bureau is constantly extending its cooperative relations with other Federal agencies. Because of similar interests along certain lines, which are becoming more generally recognized each year, much practical cooperative work is being accomplished. In this connection the bureau is indebted to officers of the United States Forest Service for the construction of trails in Alaska, for furnishing horses or other means of conveyance for the transportation of persons on trips of investigation, for the movement of supplies to field stations, and for carrying fish and fish eggs for stocking waters of our national forests in the New England States and other parts of the country. Officers of the National Park Service have rendered similar valuable assistance in the Glacier and Yellowstone National Parks and in the construction of a log hatchery on Fish Lake, near Soda Butte, on the latter reservation. The Reclamation Service has also been of assistance in furnishing transportation facilities in the movement of fish supplied for stocking waters within its control. Of particular interest and importance is the fact that these agencies have facilities for transporting fish to points that are not readily accessible by the ordinary methods.

The amicable fish-cultural relations that have heretofore existed between the bureau and the Canadian Government have been maintained. Spawn takers employed by the bureau have continued to collect eggs of the whitefish and cisco in Canadian waters, and eggs of other species have been exchanged. Shipments of fish eggs have been made to other foreign governments also, all of which are listed in the table on page 88.

SENTIMENT IN FAVOR OF FISH PROTECTION.

In view of the active interest the bureau has taken in urging the adoption of adequate protective laws for the food fishes of the country, it is a source of gratification to note a more active interest in this direction on the part of certain States. In the course of the year a number of the Southern States, which have heretofore paid little or no attention to the matter, have sought the aid and advice of the bureau in framing laws for fish protection or in connection with the establishment of hatcheries for the propagation of the fishes suited to their needs. Believing in the truth of the old saying, that "No law is stronger than the public sentiment behind it," the bureau has adhered to a policy of urging on the attention of all persons applying for fish the desirability and urgent need for protective laws and a proper respect therefor.

Part 1.—FISH PRODUCTION: PROPAGATION AND RESCUE WORK.

TABULAR SUMMARIES OF OPERATIONS.

SPECIES OF FISHES HANDLED.

The work as conducted during the fiscal year ended June 30, 1922, involved 54 species of fish, as indicated in the accompanying list, each species listed being the subject either of artificial propagation or rescue work:

LIST OF SPECIES HANDLED.

THE CATFISHES (SILURIDÆ):
- Horned pout, bullhead (*Ameiurus nebulosus*).
- Marbled catfish (*Ameiurus nebulosus marmoratus*).
- Mississippi catfish (*Ameiurus lacustris*).
- Spotted catfish, channel catfish (*Ictalurus punctatus*).
- Yellow catfish (*Leptops olivaris*).

THE SUCKERS (CATOSTOMIDÆ):
- Mongrel buffalo fish (*Ictiobus urus*).
- Common buffalo fish (*Ictiobus cyprinella*).
- Small-mouthed buffalo fish (*Ictiobus bubalus*).

THE CARPS (CYPRINIDÆ):
- Asiatic carp (*Cyprinus carpio*).

THE SHADS AND HERRINGS (CLUPEIDÆ):
- Shad (*Alosa sapidissima*).
- Glut herring (*Pomolobus æstivalis*).
- Skipjack (*Pomolobus chrysochloris*).

THE SALMONS, TROUTS, WHITEFISHES, ETC. (SALMONIDÆ):
- Common whitefishes (*Coregonus albus* and *C. clupeaformis*).
- Cisco (chiefly *Leucichthys artedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tschawytscha*).
- Chum salmon, dog salmon (*Oncorhynchus keta*).
- Humpbacked salmon, pink salmon (*Oncorhynchus gorbuscha*).
- Silver salmon, coho salmon (*Oncorhynchus kisutch*).
- Sockeye salmon, blueback salmon, redfish (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Rainbow trout (*Salmo shasta*).
- Black-spotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Cristivomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).

THE GRAYLINGS (THYMALLIDÆ):
- Montana grayling (*Thymallus montanus*).

THE SMELTS (OSMERIDÆ):
- Smelt (*Osmerus mordax*).

THE PIKES (LUCIIDÆ):
- Little pickerel (*Lucius vermiculatus*).
- Common pickerel (*Lucius lucius*).

THE MACKERELS (SCOMBRIDÆ):
- Mackerel (*Scomber scombrus*).

THE SUNFISHES, BLACK BASSES, AND CRAPPIES (CENTRARCHIDÆ):
- Crappies (*Pomoxis annularis* and *P. sparoides*).
- Large-mouthed black bass (*Micropterus salmoides*).
- Small-mouthed black bass (*Micropterus dolomieu*).
- Rock bass (*Ambloplites rupestris*).
- Warmouth bass, goggle-eye (*Chænobryttus gulosus*).
- Bluegill sunfish (*Lepomis pallidus*).
- Common sunfish (*Eupomotis gibbosus*).

THE PERCHES (PERCIDÆ):
  Pike perch (*Stizostedion vitreum*).
  Yellow perch (*Perca flavescens*).
THE SEA BASSES (SERRANIDÆ):
  Striped bass, rockfish (*Roccus lineatus*).
  White bass (*Roccus chrysops*).
  White perch (*Morone americana*).
  Sea bass (*Centropristes striatus*).
THE PORGIES (SPARIDÆ):
  Scup, scuppaug (*Stenotomus chrysops*).
THE DRUMS (SCIÆNIDÆ):
  Fresh-water drum, lake sheepshead (*Aplodinotus grunniens*).
THE CODS (GADIDÆ):
  Cod (*Gadus callarias*).
  Haddock (*Melanogrammus æglefinus*).
  Pollock (*Pollachius virens*).
THE FLOUNDER (PLEURONECTIDÆ):
  Winter flounder, American flatfish (*Pseudopleuronectes americanus*).
  Pole flounder (*Glyptocephalus cynoglossus*).

OUTPUT.

The combined work of the fish-cultural stations and the rescue crews during the year resulted in a net output of 5,125,101,320 fish and fish eggs for distribution as compared with 4,962,489,405 for the year previous. Some points of interest to be noted in comparing the appended tables summarizing by species the net outputs for the fiscal years 1922 and 1921 are an increase in the fiscal year 1922 of approximately 50 per cent in the output of fingerling fish and of about 3 per cent in the aggregate output, accomplished with a decrease of about 6 per cent in operating costs. The cost per million of the fish and fish eggs produced during 1922 was $120.36 as against $128.06 per million for 1921. Of the total output for 1922 all but approximately 35,000,000 may properly be classed as of direct commercial importance.

Summary, by species, of net output of fish and fish eggs, fiscal years 1922 and 1921.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
1922				
Catfish			52,137,880	52,137,880
Buffalo fish	86,906,000	51,000,000	3,341,480	141,247,480
Carp		82,050,000	22,006,805	104,056,805
Shad		63,461,200		63,461,200
Glut herring		82,600,000		82,600,000
Whitefish	156,242,000	306,350,000		462,592,000
Cisco	220,690,000	47,400,000		268,090,000
Chinook salmon	1,400,000	1,311,550	57,769,870	60,481,420
Chum salmon		1,540,000	14,027,610	15,567,610
Humpbacked salmon		369,860	1,119,400	1,489,260
Silver salmon		600,000	11,074,940	11,674,940
Steelhead salmon	450,000	20,000	2,028,220	2,498,220
Sockeye salmon	150,000	32,600,000	59,522,365	92,272,365
Atlantic salmon		1,334,000	180	1,334,180
Landlocked salmon	115,000	187,230	95,780	398,010
Rainbow trout	21,377,840	410,700	4,439,685	7,228,225
Black-spotted trout	1,097,500	493,400	931,000	2,521,900
Loch Leven trout			56,000	56,000
Lake trout	2,796,000	29,359,365	213,090	32,368,455
Brook trout	255,000	3,019,050	6,717,805	9,991,855
Grayling		250,000		250,000
Smelt		300,000		300,000
Pike and pickerel			679,795	679.795

Summary, by species, of net output of fish and fish eggs, etc.—Continued.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
1922				
Mackerel		1,980,000		1,980,000
Crappie			36,468,545	36,468,545
Large-mouthed black bass		281,700	1,652,710	1,934,410
Small-mouthed black bass		568,250	76,990	645,240
Rock bass		800	52,095	52,895
Warmouth bass			2,515	2,515
Sunfish			52,697,985	52,697,985
Pike perch	79,650,000	55,897,500	34,390	135,581,890
Yellow perch	34,400,000	207,527,000	1,604,350	243,531,350
Striped bass		25,530,000		25,530,000
White bass			36,510	36,510
Sea bass		32,000		32,000
Scup		2,505,000		2,505,000
Fresh-water drum			242,025	242,025
Cod	208,224,000	232,131,000		440,355,000
Haddock	75,960,000	290,820,000		366,780,000
Pollock		327,380,000		327,380,000
Winter flounder	193,178,000	1,867,378,000		2,060,556,000
Pole flounder	5,090,000			5,090,000
Miscellaneous fishes			10,402,355	10,402,355
Total	1,068,981,340	3,716,687,605	339,432,375	5,125,101,320
1921.				
Catfish			35,257,070	35,257,070
Buffalo fish		108,307,000	1,645,835	109,952,835
Carp		106,043,000	3,918,580	109,961,580
Shad		32,792,275		32,792,275
Glut herring		43,815,000		43,815,000
Whitefish	181,650,000	238,800,000		420,450,000
Cisco	186,510,000	89,800,000		276,310,000
Chinook salmon	6,780,000		32,780,765	39,560,765
Chum salmon		7,000,000	19,436,400	26,436,400
Silver salmon		600,000	6,486,150	7,086,150
Sockeye salmon	350,000	38,778,500	30,434,500	69,563,000
Steelhead salmon	493,000	38,810	2,928,915	3,460,725
Atlantic salmon		1,387,000	280	1,387,280
Landlocked salmon	575,000	208,115	124,250	907,365
Rainbow trout	2,553,240	414,100	3,872,225	6,839,565
Black-spotted trout	820,000	3,899,100	1,000,300	5,719,400
Loch Leven trout			64,000	64,000
Lake trout	2,824,000	16,563,300	208,500	19,595,800
Brook trout	856,890	3,642,330	7,559,625	12,058,845
Grayling		1,400,000		1,400,000
Smelt	600,000	7,000,000		7,600,000
Pike and pickerel			540,510	540,510
Crappie			37,303,900	37,303,900
Large-mouthed black bass		585,050	1,221,905	1,806,955
Small-mouthed black bass		303,700	54,590	358,290
Rock bass			108,305	108,305
Warmouth bass			100	100
Sunfish			30,371,475	30,371,475
Pike perch	296,475,000	57,385,000	108,515	353,968,515
Yellow perch	12,000,000	176,369,450	6,166,435	194,535,885
Striped bass		20,184,000		20,184,000
White bass			27,170	27,170
Fresh-water drum			34,080	34,080
Cod	208,800,000	175,341,000		384,141,000
Haddock	188,940,000	271,880,000		460,820,000
Pollock		455,066,000		455,066,000
Winter flounder		1,768,660,000		1,768,660,000
Pole flounder	19,410,000			19,410,000
Miscellaneous fishes			4,935,165	4,935,165
Total	1,109,637,130	3,626,262,730	226,589,545	4,962,489,405

EGG COLLECTIONS.

The egg collections for the year were obtained from the usual sources without material change in methods of procedure or the entrance into new fields. A comparison of the work with the year previous indicates the usual fluctuations in the numbers of the vari-

ous species handled, caused primarily by local conditions of wind and weather. The total of the egg collections for the fiscal year 1922 exceeds that of the previous year by more than 431,000,000. It is evident that the annual egg collections represent practically the maximum production of the present fields of endeavor and that an increased volume of work, or an extension of the practical benefits of artificial propagation, can be accomplished only by the development of new fields. There are many points in various parts of the country affording excellent opportunities for such extension and promising most satisfactory results in practical returns to the fisheries. Any further extension of the work can be undertaken, however, only when additional funds are available.

Comparison of egg collections, fiscal years 1922 and 1921.

Species.	1922	1921	Species.	1922	1921
Buffalo fish	199,906,250	163,267,000	Lake trout	67,426,500	44,247,500
Carp	98,000,000	117,218,000	Brook trout	17,986,250	16,110,810
Shad	82,579,000	37,549,000	Smelt	300,000	8,000,000
Glut herring	116,920,000	55,130,000	Mackerel	2,022,000	
Whitefish	623,100,000	540,776,000	Pike perch	254,717,500	508,942,000
Cisco	429,900,000	317,200,000	Yellow perch	277,501,870	218,333,750
Chinook salmon	64,756,100	43,829,820	Striped bass	48,745,000	24,600,000
Chum salmon	22,830,000	28,182,000	Sea bass	32,000	
Humpbacked salmon	1,722,000		Scup	3,425,000	
Silver salmon	13,618,500	8,273,000	Cod	587,426,000	482,012,000
Sockeye salmon	119,214,350	76,012,500	Haddock	543,110,000	635,950,000
Steelhead salmon	7,302,800	1,603,000	Pollock	507,270,000	650,850,000
Atlantic salmon	572,040	911,720	Winter flounder	2,312,029,000	1,980,291,000
Landlocked salmon	445,000	1,063,200	Pole flounder	5,090,000	19,410,000
Rainbow trout	11,210,500	10,994,750			
Black-spotted trout	9,220,300	5,993,600	Total	6,428,487,030	5,996,844,870
Loch Leven trout	109,870	94,220			

RESCUED FISHES.

The salvaging of stranded fishes from the overflowed lands along the Mississippi River has continued to be one of the most important and popular features of the bureau's work in fish conservation. During the fiscal year 1922 this work attained its greatest volume in the numbers of fish handled. A total of 179,475,069 fish were salvaged and either returned to original waters or delivered to applicants for planting in adjacent territory. The salvaged fishes comprise practically every useful species indigenous to the region. The table indicates by localities and by species the total numbers of fish salvaged, the numbers restored to original waters, and the numbers delivered to applicants. A full discussion of the more important details of the work occurs on page 57.

Number and disposition of fish rescued, fiscal year 1922.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Bellevue, Iowa:			
Black bass	16,052	21,460	37,512
Buffalo fish		357,000	357,000
Carp	300	6,929,700	6,930,000
Catfish	28,295	2,286,425	2,314,720
Crappie	7,755	4,326,730	4,334,485
Drum	60		60
Pike and pickerel		460	460

Number and disposition of fish rescued, fiscal year 1922—Continued.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Bellevue, Iowa—Continued.			
Pike perch		340	340
Rock bass	1,180		1,180
Sunfish	41,480	13,147,900	13,189,380
White bass		725	725
Yellow perch	625	1,105	1,730
Miscellaneous		6,274,025	6,274,025
Total	95,747	33,345,870	33,441,617
Fairport, Iowa, and auxiliaries:			
Black bass		21,200	21,200
Buffalo fish		320,865	320,865
Carp		47,460	47,460
Catfish		223,935	223,935
Crappie		345,870	345,870
Sunfish		315,195	315,195
White bass		1,575	1,575
Miscellaneous		9,420	9,420
Total		1,285,520	1,285,520
Homer, Minn:			
Black bass	60,440	166,730	227,170
Buffalo fish		61,506	61,506
Carp	40	3,483,905	3,483,945
Catfish	17,720	8,946,375	8,964,095
Crappie	8,207	12,707,503	12,715,710
Drum		25,585	25,585
Pike and pickerel		598,673	598,673
Sunfish	61,260	11,549,725	11,610,985
White bass		14,460	14,460
Yellow perch	6,900	1,209,885	1,216,785
Miscellaneous		14,450	14,450
Total	154,567	38,778,797	38,933,364
La Crosse, Wis:			
Black bass	46,885	51,130	98,015
Buffalo fish	4,570	1,185,355	1,189,925
Carp	110	7,421,240	1,421,350
Catfish	23,230	26,492,970	26,516,200
Crappie	13,030	14,564,180	14,577,210
Drum		7,280	7,280
Pike and pickerel		62,930	62,930
Pike perch		34,050	34,050
Sunfish	46,040	19,539,510	19,585,550
White bass		13,300	13,300
Yellow perch	1,465	342,845	344,310
Miscellaneous		4,030,460	4,030,460
Total	135,330	73,745,250	73,880,580
Marquette, Iowa:			
Black bass	26,756	22,230	48,986
Buffalo fish		1,007,550	1,007,550
Carp		3,854,900	3,854,900
Catfish	24,680	13,610,200	13,634,880
Crappie	6,075	4,238,405	4,244,480
Drum		209,100	209,100
Pike and pickerel		17,730	17,730
Rock bass		2,800	2,800
Sunfish	7,341	6,736,179	6,743,520
White bass		6,250	6,250
Yellow perch	1,745	39,780	41,525
Miscellaneous		54,000	54,000
Total	66,597	29,799,124	29,865,721
Meredosia, Ill:			
Black bass	2,100	15,827	17,927
Buffalo fish		306,600	306,600
Carp	150	269,000	269,150
Catfish	11,500	425,450	436,950
Crappie	580	243,520	244,100
Sunfish	8,585	658,755	667,340
White bass		200	200
Miscellaneous		20,000	20,000
Total	22,915	1,939,352	1,962,267

Number and disposition of fish rescued, fiscal year 1922—Continued.

Station and species	Delivered to applicants.	Restored to original waters.	Total.
San Marcos, Tex:			
Black bass		11,500	11,500
Catfish		32,500	32,500
Sunfish		62,000	62,000
Total		106,000	106,000
Total of all stations:			
Black bass	152,233	310,077	462,310
Buffalo fish	4,570	3,238,876	3,243,446
Carp	600	22,006,205	22,006,805
Catfish	105,425	52,017,855	52,123,280
Crappie	35,647	36,426,208	36,461,855
Drum	60	241,965	242,025
Pike and pickerel		679,793	679,793
Pike perch		34,390	34,390
Rock bass	1,180	2,800	3,980
Sunfish	164,706	52,009,264	52,173,970
White bass		36,510	36,510
Yellow perch	10,735	1,593,615	1,604,350
Miscellaneous		10,402,355	10,402,355
Grand total	475,156	178,999,913	179,475,069

STATIONS AND SUBSTATIONS AND OUTPUT OF EACH.

The fish-cultural work was conducted from the 73 regularly established stations, no funds being available for new construction. The main stations, with their substations operative during the fiscal year 1922, are listed alphabetically in the accompanying table, which also indicates the period of operation of each and the numbers of fish and eggs produced at each point by artificial propagation, by transfers from field stations, and from rescue operations.

Stations and substations operated and output of each, fiscal year 1922.

[Asterisk (*) indicates that additional eggs were transferred to other stations. See table, p. 18. All stations and substations operated the entire year, except those where months are given.]

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Afognak, Alaska	Sockeye salmon		4,100,000	28,480,000	32,580,000
Baird, Calif.	Chinook salmon			1,500,000	1,500,000
Battle Creek, Calif.	do			2,386,000	2,386,000
Mill Creek, Calif.	do			1,986,200	1,986,200
Baker Lake, Wash.	Sockeye salmon		3,950,000	4,340,000	8,290,000
Birdsview, Wash.	Chinook salmon			521,720	521,720
	Humpbacked salmon			111,000	111,000
	Silver salmon			7,085,240	7,085,240
	Sockeye salmon			40,000	40,000
	Steelhead salmon	*55,000		78,000	133,000
Brinnon, Wash. (November–February).	Chum salmon		1,040,000		1,040,000
	Silver salmon			24,700	24,700
Duckabush, Wash.	Chum salmon		500,000	7,127,960	7,627,960
	Humpbacked salmon			783,800	783,800
	Silver salmon			309,000	309,000
	Steelhead salmon			90,300	90,300
Quilcene, Wash.	Chum salmon			6,899,650	6,899,650
	Silver salmon			450,000	450,000
	Steelhead salmon	*60,000		93,100	153,100
Quinault, Wash.	Chinook salmon			47,000	47,000
	Silver salmon		600,000	948,000	1,548,000
	Sockeye salmon		250,000	3,295,000	3,545,000

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Baker Lake, Wash.—Continued.					
Sultan, Wash.	Chinook salmon			147,300	147,300
	Humpbacked salmon			14,600	14,600
	Silver salmon			2,148,000	2,148,000
	Steelhead salmon			104,400	104,400
Berkshire, Mass.	Brook trout			217,420	217,420
	Pike perch		3,000,000		3,000,000
	Rainbow trout			41,677	41,677
	Yellow perch		200,000		200,000
Boothbay Harbor, Me.	Winter flounder		922,777,000		922,777,000
Bozeman, Mont.	Black-spotted trout			392,000	392,000
	Brook trout			454,175	454,175
	Rainbow trout			395,000	395,000
Glacier Park, Mont. (July and August; June).	Black-spotted trout			168,000	168,000
	Brook trout			48,000	48,000
	Rainbow trout			250,000	250,000
Meadow Creek, Mont. (April-June).	Black-spotted trout		425,000		425,000
	Rainbow trout	*540,000	30,000		570,000
Cape Vincent, N. Y.	Brook trout		410,500		410,500
	Cisco	*215,690,000	47,400,000		263,090,000
	Lake trout		743,200		743,200
	Rainbow trout		157,000		157,000
	Whitefish	*100,242,000	32,000,000		132,242,000
	Yellow perch		10,000,000		10,000,000
Central Station, Washington, D. C.	Brook trout			1,200	1,200
	Chinook salmon			6,000	6,000
	Large-mouthed black bass			45	45
	Rainbow trout			33,775	33,775
	Sunfish			190	190
	Yellow perch		2,000,000		2,000,000
Bryans Point, Md. (March-May).	Shad		35,802,200		35,802,200
	Yellow perch	(*)	171,102,700		171,102,700
Clackamas, Oreg.	Black-spotted trout			23,000	23,000
	Brook trout		50,000	120,000	170,000
	Chinook salmon	(*)	100,000	8,957,300	9,057,300
	Grayling		250,000		250,000
	Rainbow trout			69,965	69,965
Applegate, Oreg.	Silver salmon			110,000	110,000
	Steelhead salmon	*150,000		1,552,700	1,702,700
Big White Salmon, Wash.	Chinook Salmon			14,834,000	14,834,000
Little White Salmon, Wash.	Chinook salmon	1,400,000		24,582,000	25,982,000
	Sockeye salmon			26,365	26,365
Rogue River, Oreg.	Chinook salmon		1,211,550	344,350	1,555,900
	Steelhead salmon			109,720	109,720
Salmon, Idaho (July-September).	Chinook salmon			224,000	224,000
Sandy River, Oreg. (August-September; April-July).	Chinook salmon			123,000	123,000
Upper Clackamas, Oreg.	Chinook salmon			2,111,000	2,111,000
Washougal, Wash. (April-June).	Steelhead salmon	185,000			185,000
Cold Springs, Ga.	Catfish			8,200	8,200
	Crappie			325	325
	Large-mouthed black bass		45,000	84,985	129,985
	Sunfish			87,000	87,000
Craig Brook, Me.	Atlantic salmon	(*)	1,334,000	180	1,334,180
	Brook trout		491,000	57,600	548,600
	Humpbacked salmon		369,860		369,860
	Landlocked salmon		64,000		64,000
	Rainbow trout		24,000		24,000
Duluth, Minn.	Brook trout		110,000		110,000
	Lake trout	*1,550,000	11,724,000	151,000	13,326,000
	Pike perch		150,000		150,000
	Rainbow trout		31,200	58,800	90,000
	Whitefish		15,950,000		15,950,000
Edenton, N. C.	Glut herring		82,600,000		82,600,000
	Large-mouthed black bass			38,509	38,509
	Shad		27,659,000		27,659,000
	Sunfish			12,175	12,175
Weldon, N. C. (April-May).	Striped bass		25,530,000		25,530,000
Erwin, Tenn.	Brook trout		57,000	159,000	216,000
	Large-mouthed black bass		2,000	19,620	21,620

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Erwin, Tenn.—Con.	Rainbow trout	*100,000		669,000	769,000
	Rock bass			13,850	13,850
	Small-mouthed black bass			6,305	6,305
	Sunfish			20,706	20,706
Fairport, Iowa, and four substations.	Buffalo fish			418,905	418,905
	Carp			47,460	47,460
	Catfish			223,935	223,935
	Crappie			345,870	345,870
	Large-mouthed black bass			21,200	21,200
	Sunfish			425,375	425,375
	Warmouth bass			1,860	1,860
	White bass			1,575	1,575
	Miscellaneous			9,420	9,420
Gloucester, Mass.	Cod	124,060,000	145,750,000		269,810,000
	Winter flounder		100,220,000		100,220,000
	Haddock	75,960,000	290,820,000		366,780,000
	Pole flounder	5,090,000			5,090,000
	Pollock		327,380,000		327,380,000
Green Lake, Me.	Brook trout		129,600		129,600
	Landlocked salmon	*15,000	122,230		137,230
	Small-mouthed black bass		22,000		22,000
	Smelt		300,000		300,000
Grand Lake Stream, Me.	Brook trout	5,000	101,830		106,830
	Landlocked salmon	100,000	21,000	67,860	188,860
Homer, Minn.	Buffalo fish	57,056,000		61,506	57,117,506
	Carp			3,483,945	3,483,945
	Catfish			8,964,095	8,964,095
	Crappie			12,715,710	12,715,710
	Fresh-water drum			25,585	25,585
	Large-mouthed black bass			227,170	227,170
	Pike and pickerel			598,673	598,673
	Rock bass			4,100	4,100
	Sunfish			11,610,985	11,610,985
	White bass			14,460	14,460
	Yellow perch			1,216,785	1,216,785
	Miscellaneous			14,450	14,450
Atchafalaya, La. (March-April).	Buffalo fish	29,850,000	51,000,000		80,850,000
Bellevue, Iowa (July-November)	Buffalo fish			357,000	357,000
	Carp			6,930,000	6,930,000
	Catfish			2,314,720	2,314,720
	Crappie			4,334,485	4,334,485
	Fresh-water drum			60	60
	Large-mouthed black bass			37,512	37,512
	Pike and pickerel			460	460
	Pike perch			340	340
	Rock bass			1,180	1,180
	Sunfish			13,189,380	13,189,380
	White bass			725	725
	Yellow perch			1,730	1,730
	Miscellaneous			6,274,025	6,274,025
La Crosse, Wis.	Brook trout			465,400	465,400
	Buffalo fish			1,189,925	1,189,925
	Carp			7,421,350	7,421,350
	Catfish			26,516,200	26,516,200
	Crappie			14,577,210	14,577,210
	Fresh-water drum			7,280	7,280
	Large-mouthed black bass			98,015	98,015
	Pike and pickerel			62,930	62,930
	Pike perch		450,000	34,050	484,050
	Rainbow trout			33,000	33,000
	Sunfish			19,585,550	19,585,550
	White bass			13,300	13,300
	Yellow perch			344,310	344,310
	Miscellaneous			4,030,460	4,030,460
Marquette, Iowa (July-November)	Buffalo fish			1,007,550	1,007,550
	Carp			3,854,900	3,854,900
	Catfish			13,634,880	13,634,880
	Crappie			4,244,480	4,244,480
	Fresh-water drum			209,100	209,100
	Large-mouthed black bass			48,986	48,986
	Pike and pickerel			17,730	17,730
	Rock bass			2,800	2,800
	Sunfish			6,743,520	6,743,520
	White bass			6,250	6,250
	Yellow perch			41,525	41,525
	Miscellaneous			54,000	54,000
Meredosia, Ill. (July-September)	Buffalo fish			306,600	306,600
	Carp			269,150	269,150
	Catfish			436,950	436,950

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Finger-lings, year-lings, and adults.	Total.
Homer, Minn.—Con.					
Meredosia, Ill. (July-September)—Continued.	Crappie			244,100	244,100
	Large-mouthed black bass			17,927	17,927
	Sunfish			667,340	667,340
	White bass			200	200
	Miscellaneous			20,000	20,000
Leadville, Colo	Black-spotted trout			348,000	348,000
	Brook trout	(*)	485,000	2,786,000	3,271,000
	Lake trout			25,000	25,000
	Loch Leven trout			20,000	20,000
	Rainbow trout			99,100	99,100
Yellowstone Park, Wyo. (July-September).	Black-spotted trout	*1,097,500	68,000		1,165,500
	Rainbow trout		80,000		80,000
Louisville, Ky	Large-mouthed black bass			1,225	1,225
	Rock bass			1,800	1,800
	Small-mouthed black bass.		345,000	1,500	346,500
	Sunfish			64,740	64,740
	Yellow perch		225,000	310	225,310
Mammoth Spring, Ark.	Large-mouthed black bass.		14,000	24,520	38,520
	Rock bass			3,450	3,450
	Small-mouthed black bass.		63,000	2,600	65,600
	Sunfish			13,200	13,200
Manchester, Iowa	Brook trout			597,150	597,150
	Pike perch		60,000		60,000
	Rainbow trout	*126,600		159,590	286,190
	Rock bass		800	8,600	9,400
	Small-mouthed black bass.			480	480
Nashua, N. H	Brook trout			475,550	475,550
	Lake trout			16,100	16,100
	Landlocked salmon			20,000	20,000
	Pike perch		1,250,000		1,250,000
	Rainbow trout			26,880	26,880
	Small-mouthed black bass.		19,500		19,500
	Yellow perch		200,000		200,000
Neosho, Mo	Crappie			4,290	4,290
	Large-mouthed black bass.			52,569	52,569
	Rainbow trout	244,000		433,847	677,847
	Rock bass			1,973	1,973
	Small-mouthed black bass.			223	223
	Sunfish			58,485	58,585
	Yellow perch	4,000,000	900,000		4,900,000
Northville, Mich	Brook trout		40,000		40,000
	Rainbow trout		88,000	1,800	89,800
	Small-mouthed black bass.		82,750	64,125	146,875
Alpena, Mich. (November-December; March-April).	Lake trout		1,204,000		1,204,000
	Whitefish		3,800,000		3,800,000
Bay City, Mich. Apr. 1-28).	Pike perch	75,450,000			75,450,000
Charlevoix, Mich	Brook trout		10,000		10,000
	Lake trout	*1,246,000	15,520,000		16,766,000
	Whitefish	160,000	50,000,000		50,160,000
Orangeburg, S. C	Catfish			440	440
	Crappie			395	395
	Large-mouthed black bass.		131,700	126,086	257,786
	Sunfish			13,735	13,735
	Warmouth bass			655	655
Put in Bay, Ohio	Carp		82,050,000		82,050,000
	Cisco	5,000,000			5,000,000
	Pike perch	*4,200,000	46,000,000		50,200,000
	Whitefish	*55,840,000	204,600,000		260,440,000
	Yellow perch	*30,000,000	16,000,000		46,000,000
St. Johnsbury, Vt	Brook trout		932,120		932,120
	Lake trout		45,900		45,900
	Small-mouthed black bass.			1,950	1,950
Holden, Vt	Brook trout		312,000	58,750	370,750
	Lake trout		122,265	20,990	143,255
	Landlocked salmon			7,925	7,925

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
St. Johnsbury, Vt.—Continued.					
Holden, Vt.—Con.	Rainbow trout			11,900	11,900
Swanton, Vt. (March-May).	Pike perch	(*)	4,987,000		4,987,000
	Yellow perch	*400,000	6,900,000		7,300,000
San Marcos, Tex	Catfish			37,500	37,500
	Crappie			620	620
	Large-mouthed black bass.			883,545	883,545
	Rock bass			845	845
	Sunfish			86,035	86,035
Saratoga, Wyo	Brook trout			398,500	398,500
	Loch Leven trout			9,000	9,000
	Rainbow trout	*446,240		478,500	924,740
Spearfish, S. Dak	Brook trout			301,500	301,500
	Loch Leven trout			27,000	27,000
	Rainbow trout			181,500	181,500
Springville, Utah	Brook trout	*250,000		95,260	345,260
	Catfish			960	960
	Rainbow trout	276,000		548,500	824,500
Tupelo, Miss	Crappie			1,075	1,075
	Large-mouthed black bass.		23,500	273,210	296,710
	Sunfish			86,600	86,600
White Sulphur Springs, W. Va.	Brook trout			618,950	618,950
	Large-mouthed black bass.		64,500	1,400	65,900
	Rainbow trout	*560,000		716,600	1,276,600
	Rock bass			5,160	5,160
	Small-mouthed black bass.		36,000	375	36,375
	Sunfish			16,600	16,600
Woods Hole, Mass	Cod	*84,164,000	86,381,000		170,545,000
	Winter flounder	193,178,000	844,381,000		1,037,559,000
	Steelhead salmon		20,000		20,000
	Miscellaneous		4,517,000		4,517,000
ytheville, Va	Brook trout			53,000	53,000
	Large-mouthed black bass.		1,000	6,685	7,685
	Rainbow trout	*85,000		307,850	392,850
	Rock bass			8,600	8,600
	Sunfish			16,900	16,900
Yes Bay, Alaska	Humpbacked salmon			210,000	210,000
	Sockeye salmon	150,000	24,300,000	23,340,000	47,790,000
Gross output		1,068,981,340	3,716,707,605	339,576,253	5,125,265,198
Loss in transit			20,000	143,878	163,878
Net output		1,068,981,340	3,716,687,605	339,432,375	5,125,101,320

EGG-COLLECTING OR AUXILIARY STATIONS.

In addition to the stations and substations listed in the foregoing table there are operated each year a varying number of field or auxiliary stations from which egg collections are made. These are temporary stations occupied only during the spawning season, or mere camps that are shifted from time to time as the exigencies of the work may make advisable. The eggs obtained at these field stations are either transferred to the main hatcheries for incubation immediately in the green stage, or, where the distance involved is too great to permit of making the transfer of green eggs, they are retained at the collecting station until reaching the eyed stage before transfer takes place. At points on the Great Lakes and off the New England coast egg collections are made by the bureau's boats in favorable localities. The following stations were operative for egg collections during 1922. The period of occupation and the species of fish eggs produced are noted in each case.

Egg-collecting stations, period of operation, and species handled, fiscal year 1922.

Station.	Period of operation.	Species handled.
Boothbay Harbor, Me.:		
Cundys Harbor, Me	March	Winter flounder.
Linekins Bay, Me	March and April	Do.
Pemaquid, Me	March	Do.
Phippsburg, Me	March and April	Do.
Rockland, Me	do	Do.
Southport, Me	do	Do.
Thomaston, Me	do	Do.
Cape Vincent, N. Y.:		
Bygotts Point, Ontario	November	Cisco, whitefish.
Chaumont Bay, N. Y	do	Do.
Deseronto, Ontario	do	Do.
Fairhaven Bay, N. Y	do	Cisco.
Grass Bay, N. Y	April	Yellow perch.
Henderson Bay, N. Y	November	Cisco.
Pigeon Island, Ontario	October and November	Lake trout.
Stony Island, N. Y	do	Do.
Sodus Bay, N. Y	November	Whitefish.
South Bay, Ontario	do	Cisco.
Clackamas, Oreg.:		
Lemhi, Idaho	June to September	Chinook salmon.
Pahsimeroi, Idaho	do	Do.
Duluth, Minn.:		
Au Train, Mich	October	Lake trout.
Betsie River, Mich	do	Do.
Fishermans Home, Mich	September to November	Lake trout, whitefish.
Fish Island, Mich	do	Do.
Gay, Mich	October	Lake trout.
Grand Marais, Mich	do	Do.
Isle Royale, Mich	do	Do.
Keystone, Mich	do	Do.
Long Point, Mich	September to November	Lake trout, whitefish.
Manitou Island, Mich	October	Lake trout.
Marquette, Mich	October to November	Do.
Munising, Mich	do	Do.
Portage Entry, Mich	do	Do.
Portage Lake Canal, Mich	October	Do.
Rock Harbor, Mich	September to November	Lake trout, whitefish.
Siscowit Bay, Mich	do	Do.
Tobens Harbor, Mich	do	Do.
Todds Harbor, Mich	do	Do.
Washington Harbor, Mich	do	Do.
Leadville, Colo.:		
Carroll Lake, Colo	October and November	Brook trout, Loch Leven trout.
Englebrecht Lake, Colo	September to November	Brook trout.
Evergreen Lakes, Colo	October and November	Do.
Fred Neal Lake, Colo	do	Do.
Musgroves Lake, Colo	do	Do.
Northfield Lake, Colo	do	Do.
Turquoise Lake, Colo	do	Do.
Yellowstone Park, Wyo	July to September and June.	Black-spotted trout.
Chipmunk Creek	July	Do.
Clear Creek	do	Do.
Columbine Creek	do	Do.
Cub Creek	do	Do.
Flat Mount Arm	do	Do.
Grouse Creek	do	Do.
Pelican Creek	do	Do.
Soda Butte	June	Do.
Thumb Creek	July	Do.
Nashua, N. H.: Lake Sunapee, N. H	June	Small-mouthed black bass.
Neosho, Mo.: Roaring River, Mo	November to February	Rainbow trout.
Northville, Mich:		
Fairport, Mich	November	Lake trout.
Frankfort, Mich	do	Do.
Gould City, Mich	do	Whitefish.
Manistique, Mich	do	Lake trout.
Naubinway, Mich	do	Whitefish.
Northport, Mich	do	Lake trout.
St. James, Mich	do	Do.
St. Joseph, Mich	do	Do.
Put in Bay, Ohio:		
Catawba Island, Ohio	November and December	Whitefish.
Middle Bass Island, Ohio	do	Do.
	April and May	Yellow perch.
North Bass Island, Ohio	November and December	Whitefish.
	April	Pike perch.
Port Clinton, Ohio	November	Whitefish.
	April to June	Pike perch, yellow perch, carp.
Toledo, Ohio	November	Whitefish.
	April	Pike perch.

Egg-collecting stations, period of operation, and species handled, etc.—Continued.

Station.	Period of operation.	Species handled.
St. Johnsbury, Vt.:		
Darling Pond, Vt	October and November	Brook trout.
Lake Mitchell, Vt	....do	Do.
Margalloway River, Me	September and October	Do.
Parmacheence Lake, Me	October	Do.
York Pond, N. H	Entire year	Do.
Saratoga, Wyo.:		
Canon Creek, Wyo	April to June	Rainbow trout.
Lost Creek, Wyo	....do	Do.
Sage Creek, Wyo	....do	Do.
Springville, Utah: Fish Lake, Utah	November	Brook trout.
Woods Hole, Mass:		
Newport, R. I	March and April	Winter flounder.
Waquoit, Mass	January to March	Do.
Wickford, R. I	March	Do.

TRANSFERS OF EGGS BETWEEN STATIONS.

Every year fish eggs in considerable numbers are transferred from one station to another. The primary object of such transfers is usually to give advantageous distribution centers for the resulting fry or fingerlings, as the eggs can be more economically and readily transported. Such transfers may also tend to reduce operating costs, and sometimes they represent an egg collection in excess of the hatching facilities at the collecting point. The transfers of eggs made during the fiscal year 1922 are indicated in the following table:

Transfers of eggs between stations, fiscal year 1922.[1]

Species.	Number of eggs.	From—	To—	Final disposition of fry or fingerlings.
Atlantic salmon	20,000	Craig Brook, Me.	Central station, Washington, D. C.	Lost from chlorinated water.
Black-spotted trout.	200,000	Yellowstone Park, Wyo.	Bozeman, Mont	Montana waters.
	50,000	....do	Clackamas, Oreg	Washington and Oregon waters.
	100,000	....do	Glacier Park	Glacier Park streams.
	200,000	....do	Leadville, Colo	Colorado waters.
Brook trout	500,000	Leadville, Colo	Bozeman, Mont	Colorado and Montana waters.
	300,000	Springville, Utah	....do	Do.
	400,000	....do	Cape Vincent, N. Y.	New York waters.
	400,000	....do	Clackamas, Oreg	Washington and Oregon waters.
	400,000	....do	La Crosse, Wis	Wisconsin waters.
	300,000	....do	Spearfish, S. Dak	South Dakota waters.
	150,000	....do	White Sulphur Springs, W. Va.	West Virginia waters.
Chinook salmon.[2]	20,000	Clackamas, Oreg	Central station, Washington, D. C.	Susquehanna River.
Cisco	1,500,000	Cape Vincent, N.Y.	....do	Fry killed by chlorinated water.
Cod	30,070,000	Woods Hole, Mass.	Gloucester, Mass	Massachusetts Bay.
Lake trout	50,000	Duluth, Minn	Leadville, Colo	Capitol Lake, Franklin County, Colo.
	25,000	Charlevoix, Mich.	Holden, Vt	Vermont waters.
Landlocked salmon.	70,000	Green Lake, Me	Craig Brook, Me	Maine waters.
	25,000	....do	Nashua, N. H	New Hampshire waters.
Pike perch	4,000,000	Put in Bay, Ohio.	La Crosse, Wis	Wisconsin waters.
	75,000	....do	Manchester, Iowa	Iowa waters.
	3,000,000	Swanton, Vt	Hartsville, Mass	Root Pond, Big Pond, Knights Pond, Rooths Pond.
	1,600,000	....do	Nashua, N. H	New Hampshire waters.
Rainbow trout.	500,000	Meadow Creek, Mont.	Clackamas, Oreg	Oregon and Washington waters.
	100,000	....do	Duluth, Minn	Minnesota waters.
	20,000	Erwin, Tenn	Central station, Washington, D. C.	West Branch, Patuxent River.

[1] Where the distribution of the fish resulting involves a species not common or nonindigenous to the region the name of the water in which the plants were made is given. In most cases where the species involved are common to the locality in which the distribution is made these details are omitted.

[2] For exhibit.

Transfers of eggs between stations, fiscal year 1922 —Continued.

Species.	Number of eggs.	From—	To—	Final disposition of fry or fingerlings.
Rainbow trout—Continued.	80,000	Manchester, Iowa	La Crosse, Wis	Wisconsin waters.
	100,000	Sage Creek, Wyo	Leadville, Colo	Colorado waters.
	50,000	do	Salmon, Idaho	Idaho waters.
	50,000	do	Spearfish, S. Dak	South Dakota waters.
	150,000	White Sulphur Springs, W. Va.	Cape Vincent, N. Y	New York waters.
	50,000	do	Craig Brook, Me	Maine waters.
	50,000	do	Hartsville, Mass	Massachusetts waters.
	50,000	do	Holden, Vt	Vermont waters.
	55,000	Wytheville, Va	Central station, Washington, D. C.	Lost from chlorinated waters.
	50,000	do	Nashua, N. H	New Hampshire waters.
Steelhead salmon.	25,000	Birdsview, Wash	Manchester, Iowa	Reserved for brood stock.
	25,000	do	Woods Hole, Mass	Johns Pond, Mashpee, Mass.
	20,000	Quilcene, Wash	Charlevoix, Mich	Pine Lake, Charlevoix, Mich.
	50,000	Applegate Creek	Bozeman, Mont	Montana waters.
Whitefish	1,600,000	Cape Vincent, N.Y.	Central station, Washington, D. C.	Fry lost from chlorinated water.
	24,950,000	do	Charlevoix, Mich	Lake Michigan.
	25,400,000	Put in Bay, Ohio	do	Do.
	25,500,000	do	Duluth, Minn	Lake Superior.
Yellow perch	1,800,000	do	Central station, Washington, D. C.	Lost in transit.
	200,000	Swanton, Vt	Hartsville, Mass	Western Massachusetts waters.
	400,000	do	Nashua, N. H	New Hampshire waters.
	1,000,000	Bryans Point, Md	Neosho, Mo	Missouri waters.
	200,000	do	Louisville, Ky	Ohio River-Louisville, Ky.
	500,000	do	Wytheville, Va	Lost in transit.

FISH FOOD USED AT HATCHERIES.

Since everyone undertaking a venture in the artificial propagation of fish must of necessity become interested in the problem of a suitable fish food, the following table, indicating the amounts and kinds of food used at the fish-cultural stations of the bureau during 1922, with the cost per pound, may be of interest.

Pounds and cost per pound of fish food used during fiscal year 1922.

PACIFIC SALMON STATIONS.

Station.	Salted salmon.		Canned salmon.		Frozen salmon eggs.		Beef liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Afognak, Alaska	200	$0.01						
Yes Bay, Alaska	3,000	.03						
Baker Lake and substations, Wash	4,845	.02	8,880	$0.03			873	$0.10
Baird and substations, Calif	7,000	.012					274	.09
Clackamas and substations, Oreg	31,600	.013			21,335	$0.06		
Total	46,645		[1] 8,880		21,335		1,147	

Station.	Beef spleen.		Pork liver.		Middlings.		Sheep liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Baker Lake and substations, Wash	5,520	$0.05	1,520	$0.05			462	$0.05
Baird and substations, Calif					400	$0.024		
Clackamas and substations, Oreg	7,387	.036			3,182	.02		
Total	12,907		1,520		3,582		462	

[1] 6,000 pounds furnished by Washington State fisheries department, the cost being only the cost of packing the food from Concrete to Baker Lake.

Pounds and cost per pound of fish food used during fiscal year 1922—Con.

ROCKY MOUNTAIN TROUT STATIONS.

Station.	Beef liver.		Beef hearts.		Sheep liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Bozeman and substations, Mont	7,492	$0.08				
Leadville, Colo	20	.12				
Saratoga, Wyo	1,083	.08	873	$0.065	1,946	$0.04
Spearfish, S. Dak	200	.125	629	.115	3,709	.07
Springville, Utah			9,374	.06	7,010	.05
Total	8,795		10,876		12,665	

Station.	Pork liver.		Fishotine.		Middlings.		Fresh beef.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Bozeman and substations, Mont	1,420	$0.065	49	$0.08				
Leadville, Colo							850	$0.045
Spearfish, S. Dak					2,500	$0.01		
Springville, Utah					5,700	.025		
Total	1,420		49		8,200		850	

NEW ENGLAND TROUT AND SALMON STATIONS.

Station.	Beef liver.		Beef hearts.		Beef spleen.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Berkshire trout hatchery, Mass	992	$0.11			4,356	$0.05
Craig Brook, Me	50	.09				
Green Lake, Me			308	$0.05		
Nashua, N. H	636	.09	239	.05		
St. Johnsbury and substations, Vt	713	.11	1,351	.06		
Total	2,391		1,898		4,356	

Station.	Sheep liver.		Pork liver.		Sheep plucks.		Fishotine.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Berkshire trout hatchery, Mass	350	$0.05						
Craig Brook, Me			317	$0.04				
Green Lake, Me	256	.04			38	$0.03		
Nashua, N. H	4,014	.05						
St. Johnsbury and substations, Vt							120	$0.09
Total	4,620		317		38		120	

STATIONS PROPAGATING BOTH TROUTS AND POND FISHES.

Station.	Beef liver.		Beef heart.		Sheep liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Erwin, Tenn			4,787	$0.05	10,233	$0.05
Manchester, Iowa	21	$0.12	3,818	.05	14,007	.04
Neosho, Mo			3,055	.04	6,779	.03
White Sulphur Springs, W. Va	430	.06	15,029	.05	17,694	.04
Wytheville, Va			3,530	.05	7,110	.06
Total	451		30,219		55,823	

Station.	Azotine.		Middlings.		Pork hearts.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Erwin, Tenn			4,250	$0.04		
Manchester, Iowa			860	.02		
Neosho, Mo			3,400	.02	2,794	$0.03
Wytheville, Va	150	$0.07	5,782	.02		
Total	150		14,292		2,794	

Pounds and cost per pound of fish food used during fiscal year 1922—Con.

POND FISH-CULTURAL STATIONS.

Station.[1]	Beef liver.		Beef heart.		Fresh fish.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Cold Springs, Ga., and substations			5,813	$0.07	530	$0.10
Edenton, N. C					259	.125
Louisville, Ky	42	$0.10	395	.11		
Mammoth Spring, Ark	230	.15	513	.12		
Orangeburg, S. C			1,136	.10		
Tupelo, Miss			1,700	.08		
Total	272		9,557		789	

Station.[1]	Fishotine.		Shorts.		Bone meal.		Pork liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Cold Springs, Ga., and substations	800	$0.07	500	$0.02	75	$0.07		
Louisville, Ky							5	$0.10
Total	800		500		75		5	

[1] No artificial foods used at the San Marcos (Tex.) station.

HATCHERY FISH-CULTURAL NOTES.

NEW METHOD OF PRESENTING FOOD TO TROUT FRY AND FINGERLINGS.

Of interest in connection with the subject of suitable foods for fish is the proper manner of supplying it. During 1922 a new method, recommended by an employee of the New York Aquarium, was tried at a number of the stations. It consists in placing the prepared food in shallow vessels, clamshells were suggested, at convenient intervals on the bottom of the trough or pond in which the young fish were being held. Several of the bureau's superintendents, under whose direction the test was made, were favorably impressed by the change, while with others it found little favor. Some of the comments on it are noted below:

Wytheville (Va.) Station.—The dishes were filled twice a day with finely chopped beef heart, and the fish seemed to feed continuously, a group being constantly over the containers. These fish made no better growth than did those fed by the usual methods, the mortality was not lessened, and much food was wasted.

Manchester (Iowa) Station.—The idea possesses much merit, especially in the feeding of sheep liver. The young fish learn to partake of the food readily, and very little is wasted. The idea has not proved an advantage in the feeding of beef heart.

White Sulphur Springs (W. Va.) Station.—The fish fed in the regular manner appeared to be more uniform in size, and there was no perceptible difference as to the cleanliness of the troughs.

In preparing food for fry and fingerling trout a number of the superintendents are finding the use of a common eggbeater of practical value. The meat is prepared in the usual manner and placed in a deep pan, with sufficient water to bring it to the proper consistency. It is then thoroughly mixed with an eggbeater. This removes practically all the small particles of connective tissue and muscle which ordinarily pass through the finest plate of the food chopper and are frequently troublesome in clogging the screens and fouling the troughs.

EGG MEASUREMENTS.

For practical fish-cultural purposes the desirability of adopting a standard of measurement for the eggs of such fishes as the whitefish, cisco, yellow perch, pike perch, the marine species, and others that produce eggs of small size in large numbers has long been apparent. Because of these variations in size the standard would be to some extent arbitrary, but if recognized by all fish-culturalists its practical value in keeping uniform records of eggs collected and distributed is evident.

In making shipment of such eggs from point to point it not infrequently happens that the eggs are measured by the consignor under one standard, while the consignee uses another. A recognized standard of measure would obviate this confusion. In view of the rather rapid change in the size of the eggs of most fishes after fertilization and during incubation, it is desirable to have one standard measure for eggs in the green stage and another for eyed eggs.

HATCHING EGGS IN GRAVEL.

Recently many fish-culturists have become interested in the so-called gravel method of incubating the eggs of salmon and trout. This method, originated, we believe, by Alexander Robertson, a Canadian fish-culturist, consists in placing the fertilized eggs, either green or eyed, in a suitable receptacle between alternate layers of gravel, all of the eggs being completely covered. The receptacle is then so placed as to receive a constant flow of water by seepage through the gravel, the volume not being sufficient to disturb the eggs.

Experiments conducted along this line at a number of the bureau's stations with eggs of the sockeye and chinook salmons and rainbow and brook trouts have yielded fairly uniform results. The experiments have involved placing the eggs in gravel in various kinds of containers, in hatching troughs, in rearing ponds in the open air, and in the beds of creeks. In practically every instance a good percentage of hatch has been obtained, except in cases where the water circulation was imperfect or where frost had penetrated to the eggs. The former point is illustrated by the following report from the superintendent of the St. Johnsbury (Vt.) station:

> Last winter, 1921, we put 4,000 brook-trout eggs in a box about 1 foot square under the west end of the York Pond Dam. The box was set in such a way that the water was forced up through eggs and gravel. There was a considerable loss of eggs in the corners of the box, but otherwise they hatched normally. My judgment is that the loss was due to imperfect circulation in the box.

Observers of the experiments are also very nearly unanimous in the opinion that the fry produced by this means of incubation are exceptionally virile, are darker in color than fry hatched by the usual methods, and do not emerge from the gravel until the near approach of the feeding stage.

It seems hardly probable that the method can be developed to a point where it will be of direct value in hatchery operations or that it will replace present methods of incubating the eggs of salmon and trout, particularly where such eggs are to be handled in

large numbers. It is of much interest, however, in connection with the suggested possibilities as to its value in stocking lakes and streams with eyed eggs rather than the more expensive fry or fingerlings.

The available information on the subject indicates that practically perfect results, in so far as incubation is concerned, may be expected from eyed eggs of the trouts or salmons when planted in the deep gravel bed of a suitable stream where a substream flow or spring seepage is present, and one of these conditions doubtless always obtains in a stream flowing gently over a bed of deep gravel. Trout or salmon spawning naturally in streams invariably seek such places, and trout spawning in ponds will seek seeping water, either in the nature of spring seepage entering the pond or water seeping from the pond through a porous section of its bottom. Observations made during the summer of 1921 of a number of plants of eyed eggs of the black-spotted trout in the Belcher River and tributaries, in the Yellowstone National Park, under the conditions named above, revealed a 100 per cent hatch in each instance, and the resulting fry were uniformly strong and vigorous. They displayed all the tendencies of naturally hatched fish, burying themselves in the gravel to a depth of 8 or more inches and remaining there during the time required for the absorption of the umbilical sac. The evidence at hand would indicate that eggs planted in a dead pond bottom result in total failure. If this method of stocking streams and lakes can be carried out as successfully as now seems possible, it will offer in innumerable instances many advantages over present methods. It will permit of making plants at the headwaters of streams or of the tributaries of lakes, always a desirable location, though inaccessible with fry or fingerlings, and of making distributions over a greater water area. It will also materially reduce the costs of distribution and hatchery expenses.

METHODS OF PLANTING EYED EGGS.

In making plants of eggs in the bed of a stream it is impossible, because of their buoyant tendency and the action of the current, simply to scoop out a "nest," deposit the eggs therein, and cover them with gravel. Several ways have been resorted to in making such plants. A method employed on the Pacific coast is to place the eggs to be planted in alternate layers with gravel in a box or can—a 5-gallon coal-oil can is mentioned. An excavation of sufficient size and depth is made in the gravel bed at the site selected and the can is carefully inverted into it, allowing its contents to settle into the excavation. In other places two pieces of board or plank are fastened together to form a V. This is placed in the stream with its apex against the current. The "nest" is then made in the eddy or slack water in the angle of the V.

ACCLIMATIZATION.

Throughout the history of practical fish culture numerous instances are to be noted of the successful establishment of nonindigenous fishes in various parts of this country and also in many of the foreign countries. In most cases such transplantings have resulted in

direct benefit, though in others the good effects have been less obvious. Among the more recent occurrences of this character may be mentioned the successful introduction into certain Maine rivers of the humpbacked salmon of the Pacific coast, which is referred to on page 57 of this report. The introduction of the smelt in the Great Lakes is also of interest. The bureau claims no credit and no responsibility in connection with the latter, but it is referred to as an item of interest to fish-culturists. The records show that eggs of the smelt were furnished the State of Michigan from the Green Lake (Me.) station during the fiscal years 1909, 1912, 1914, 1915, 1916, and 1921. Information reached the bureau in the spring of 1922 that the species had been noted in considerable numbers in Crystal Lake, Mich., and also in points in Lake Michigan, notably in Grand Traverse Bay.

There seems to be considerable difference of opinion as to the effect the smelt may have on the indigenous fishes. A number of persons appear to hail the advent of the smelt in the Great Lakes as a cause of rejoicing, although others are inclined to view the matter with gloomy forebodings. Aside from their value as food for humans, which is considerable, the smelt is recognized in many bodies of water as a valuable asset in the way of food for the game fish. In fact, it seems to be fairly well demonstrated that certain species of game fish, notably the landlocked salmon, do not attain to their highest quality when introduced in waters where the smelt does not occur. The final results of the establishment of smelt in the Great Lakes are, however, problematical and will be watched with interest.

COMMERCIAL FISHES.

Of the 73 stations and substations operated during the fiscal year 1922, the work of 42, including the rescue stations, was addressed to the propagation or conservation of fishes commercially important. This group of stations produced approximately 99 per cent of the entire output. The results of the season's work may be considered fairly successful. The output was increased over that of the preceding fiscal year, and the work was accomplished at a smaller outlay of funds. However, this continued reduction of funds available for fish culture is having an unfavorable effect, and it is preventing the fullest development of many valuable fields. A discussion of the more important details of the work of the stations handling the commercial fishes during the past year follows.

PACIFIC SALMONS.

In the artificial propagation of fish perhaps no branch of the work ranks higher in importance than that addressed to the salmons of the Pacific coast. While it is difficult to check the actual returns from the culture of the commercial fishes, which are distributed over wide areas in the open waters, or to say positively that an increase in the number of fish in a given locality is the result of hatchery work uninfluenced by other considerations, the evidence at hand indicates that the Pacific coast salmon hatcheries are in most instances entitled to high ranking from the standpoint of practical returns on the effort expended. Salmon hatching during the fiscal year 1922 was conducted at 20 stations, located in the States of Washington, Idaho,

Oregon, and California, and in the Territory of Alaska. The aggregate output of these stations for the year amounted to 183,992,815 eggs, fry, and fingerlings of the salmon, as against a total of 146,-107,040 the preceding year. Of the 1922 output 145,542,405 were fingerling fish, while the fingerlings produced in 1921 numbered 92,066,730.

AFOGNAK (ALASKA) STATION.

[EDWIN WENTWORTH, Superintendent.]

For the fifth consecutive season since the destruction of the spawning beds by the volcanic deposit in 1912 there was an excellent run of sockeye salmon in Letnik Lake and no trouble was experienced in obtaining the desired number of eggs, notwithstanding the escape of large numbers of fish over the racks during a period of high water in early August. It is estimated that the season's egg collection, which amounted to 53,835,000, was secured from approximately one-fourth of the salmon entering the lake. The work of incubation was hampered by a scarcity of water, as a result of dry weather extending through August and well into September. By constant and assiduous attention, however, the stock was carried through without abnormal loss, though the high temperatures prevailing during the drought caused the eggs to hatch fully three weeks earlier than under normal conditions. The stacked trays were again used in holding the fry through the period of absorbing the umbilical sac, with only nominal loss. During May, however, a disease appeared among the 12,000,000 fry remaining on hand at that time, and it soon became epidemic, causing a serious mortality. All of these fry appeared normal at the time of hatching, the trouble appearing just prior to the feeding stage, and in no instance was the disease responsive to the usual methods of treatment. There was some evidence that a similar affection obtained among the migrating sockeye fingerlings at this time, and examples of the fish from the lake and the hatchery troughs were forwarded to the division of scientific inquiry for examination.

With the purpose in view of reserving Letnik Lake solely for the spawning of the sockeye salmon, the dam at the falls in Letnik River was closed on August 25 and rendered effective service during the fall and early winter in excluding Dolly Varden trout and silver salmon. It was planned to install a trap in the river at this point, to serve as a means for obtaining a count of the sockeyes entering the lake, but the webbing shipped from Seattle for this purpose was delayed en route. As an alternative racks were installed at the outlet of the lake, and 37,653 sockeye salmon were counted through between June 7 and July 1.

A simple method of transporting the advanced fry to suitable planting areas was tried with success. The trays containing the fry were placed on a Yukon sled, with a tarpaulin folded around them, and it was found that the young fish could be transported in this manner without loss, even when out of the water for as long as 30 minutes.

Further experience in hatching eggs in gravel resulted in the loss of the entire lot involved in the experiment. When the hatching

trough used for the purpose was opened, it was found that development had been arrested at the eyed stage, and it was apparent that the water circulation had not been adequate.

The distributions from the station consisted of 5,200,000 eyed eggs, delivered to the State of Oregon for the Columbia River, and 28,480 fingerlings and 4,100,000 fry, which were liberated in local waters.

Important items of repair work at the station during the year included the renewal of sills, flooring, and floor timbers at the west end of the hatchery, the lumber used in this work being sawed on the premises. In 37 days of operation the station sawmill produced some 60,000 feet of lumber, at a cost of $20.23 per thousand feet, including the cost of logging and delivering logs at the mill. A new water-tube boiler was installed and has proved well adapted for the work, the sawmill refuse making satisfactory fuel.

YES BAY (ALASKA) STATION.

[C. H. VAN ATTA, Superintendent.]

The repairs at this station, which prevented active fish-cultural work during 1921, were so far completed at the beginning of the fiscal year 1922 that egg collections were resumed. The spawning season of the sockeye salmon opened August 29, and between that date and September 27 a total of 51,000,000 eggs were collected. During the latter half of the spawning season fishing operations were materially hampered by excessive rains, high-water stages, and a strong river current, making it difficult to handle the seines. The first eggs of the season showed the eye spots by September 27, and by November 1 the entire lot had reached that stage. All fry hatched were held on trays in the hatching troughs until the absorption of the umbilical sac. The first plant was made in Hatchery Creek on April 10, and a considerable amount of salted salmon was distributed along the margins as a food supply. Gill nets were used to keep down the numbers of trout, and the young fish made excellent growth. Further experiments were conducted in maintaining an inclosed section of the river as a feeding area for young salmon, but the results were in no case satisfactory.

The inclosed arm of McDonald Slough was again used as a rearing pond. Two million sockeye-salmon fingerlings No. 1 were placed in this inclosure on May 11, and by July 25 these fish had increased in size approximately 100 per cent. The screens were removed on September 10. In December further plants of eyed sockeye-salmon eggs to the number of 150,000 were made in Round Lake and Lake No. 2, though subsequent visits to these lakes in May and June following failed to indicate that any results had followed these or previous plants in either lake.

In connection with the sockeye-salmon egg collections, 246,000 eggs of the humpbacked salmon were taken between August 22 and September 2, producing 210,000 advanced fry for distribution.

The new water-supply system installed during the previous year functioned satisfactorily, with the exception of a period of unusually cold weather with low-water stages in the river. During this period anchor ice was a serious source of annoyance, though

no loss of eggs or fry occurred. The condition was remedied by deepening the channel from the river to the intake reservoir and covering exposed portions of the pipe line.

BAKER LAKE (WASH.) STATION AND SUBSTATIONS.

[J. R. RUSSELL, Superintendent.]

Fish-cultural operations were conducted at seven points in the Washington field, and included the propagation of all species of the Pacific salmon and the steelhead. The year's egg collections for this group of stations numbered 53,978,000, and the output of eyed eggs and young fish amounted to 41,113,770, all but about 6,000,000 of this number consisting of fish varying from 1 inch to several inches in length.

BAKER LAKE (WASH.) STATION.

The buildings in course of construction at the Baker Lake station at the beginning of the year were completed and painted. The new hatchery at this point is 130 feet long by 56 feet wide, and is equipped with 150 standard salmon hatching troughs, each 16 feet long by 14 inches wide, inside measure. It has a capacity of 30,000,000 sockeye-salmon eggs, or of 25,000,000 fry when the stacked-tray system is used. The construction of the fish trap undertaken last season at the outlet of Baker Lake was completed. This trap, which is about 350 feet long, was formed by driving piles at 8-foot intervals, beginning at each shore about 50 feet below the trap proper and leading to a V-shaped point, comprising the entrance. The piles were cut off at a level of 10 feet above the average water stage and capped with 2 by 14 inch planks. The 4-inch mesh web used to obstruct the passage of the fish is hung from the top capping of the piling and extends to the river bottom, where it is held down by a heavy chain sewed to its lower edge and further reinforced by driven stakes. The trap proper is a web pot, 18 by 20 feet in dimensions, which is connected with the leads by a tunnel made of webbing. The trap is kept in position by means of lines attached to the piling, and hand windlasses are provided for raising and lowering it. Although there was a slight decrease in the collection of both adults and eggs of the sockeye salmon, which is the principal species handled at the Baker Lake station, the results of the year's work were, in general, satisfactory, both as regards losses and the condition of the fish released from the hatchery.

There was no deviation from the methods of previous years in the work of capturing, towing, and handling adult salmon, and during the time they were held in the inclosure at the head of the lake awaiting the ripening of their eggs the death rate was very low. There was no loss whatever from floods, though the water stage at one time attained a height of 14 feet above normal.

Adult sockeyes were removed from the trap between the dates of July 2 and August 27, the total capture comprising 7,075, of which 3,186 females produced the season's stock of 10,275,000 eggs. During the spawning season, which extended from October 4 to November 24, the fish were assorted every five days and all eggs were taken in the

inclosure and transferred in tubs and pails to the hatchery. Salt solution was employed to remove infertile eggs, and the stack-tray system was effectively utilized for holding fry through the yolk-sac stage.

More silver salmon entered Baker Lake than in any year since 1915. Of a total of 4,000 adults of this species taken from the trap between September 22 and November 1 there were 2,009 females, which produced 5,750,000 eggs, an average of 2,862 per fish. Following the policy of the past two years the eggs were held at Baker Lake until the eyed stage of development and were then transferred to Birdsview substation, the losses in the meantime amounting to $4\frac{1}{3}$ per cent.

BIRDSVIEW (WASH.) SUBSTATION.

Fish-cultural work at Birdsview included operations with four species of the Pacific salmon and the steelhead. All fry hatched from eggs collected at this point were reared to fingerlings before being liberated in the principal tributaries of the Skagit River, in locations that appeared to afford the best protection from predatory birds and animals. A lot of 37,980 young chinook salmon carried over from the previous fiscal year were fed until September 20 and liberated in the No. 3 fingerling stage. As there was not sufficient water in Grandy Creek during September to permit chinook salmon to enter, the majority of the run spawned in the Skagit River below. Consequently, the egg collections declined in numbers as compared with the preceding year, the total for the season amounting to only 313,000. This stock was augmented by the receipt of 250,000 advanced fry from the Washington State fisheries department, and the fish resulting from both sources were liberated as fingerlings in tributaries of the Skagit River. A lot of 746,500 young silver salmon that were being carried in hatchery ponds on the first of the year were liberated during July, August, and September in the Nos. 2 and 3 fingerling stages. Silver salmon, believed to be the result of plants from eggs transferred from the Baker Lake station, appeared at the trap early in September. Their appearance indicated that fully a month would be required for the full development of their eggs, and, as there were no facilities for holding the fish, they were liberated above the trap and allowed to work their way farther upstream.

Between the 16th and 24th of September 141,000 eggs were collected from the run of humpbacked salmon in Grandy Creek. Though small, this number is nearly twice as large as that obtained from this stream in 1919. The majority of the humpbacked salmon entering Skagit River make their ascent during August and September, when the streams in the vicinity of the hatchery are at a low stage. Consequently, most of the fish proceed up the river some distance above the station before spawning. The principal spawning ground of the humpbacked salmon in the Skagit River lies between Rockport and Marblemount, from 15 to 20 miles above Birdsview. On May 17, 40,000 young sockeyes that had been carried over from the previous year were liberated in Grandy Creek. Though the fish received but little care during the winter and their diet was confined to canned and spawned-out salmon, the losses on the lot from the beginning of

the fiscal year to the time of planting amounted to only 7,000. They had attained an average length of 4 inches at the time of planting. From a stock of 48,000 eggs and 34,000 fry of the steelhead on hand at the beginning of the fiscal year 78,000 No. 2 fingerlings were reared and distributed during the fall in various lakes and streams in the State of Washington. Egg collections of this species began on March 30 and ended May 29, with a total of 519,000, this number exceeding last year's collection by nearly 200,000.

DUCKABUSH (WASH.) SUBSTATION.

It is estimated that during late August and early September a sufficient number of chum salmon entered the Duckabush River to permit of a collection of 15,000,000 eggs. Unforunately, it was impossible to capture more than a small percentage, as nearly three-fourths of them escaped over the traps during a period of high water. Fishing and spawning operations were conducted from August 30 to September 20, and 4,501,000 eggs were secured. A second run of this species occurred about the middle of November, but the water stages were even more difficult, and only 140,000 eggs were taken. From a small run of humpbacked salmon entering the river with the early chums, a collection of 874,000 eggs was made. Silver salmon operations included the planting of 109,000 fingerlings No. 2, carried over from the stock of the previous year, and the collection of 537,000 eggs, the latter being obtained at irregular intervals between November 28 and March 11. As a rule, silver salmon ascend the Duckabush throughout the winter, individuals frequently being seen as late as May 1. The fish are hard to capture, however, as they travel mostly on high-water stages and easily escape the traps. Therefore, while the collection made is a fair average for the station, it does not represent more than 20 per cent of the total run. The product of these eggs was returned to the river in the fingerling Nos. 1 and 2 stages. The year's output from this hatchery also included 78,000 steelhead fingerlings No. 1, which were liberated in the Duckabush River and adjacent tributaries.

BRINNON (WASH.) SUBSTATION.

From chum salmon entering Walcot Slough on flood tide and caught with a seine on the ebb 10,790,000 eggs were taken, the collections commencing on November 22 and ending December 31. As fish were still running at the rate of several hundred per day after the collections had been discontinued, the trap pickets were removed to allow them to pass unhindered to the spawning grounds above. After development to the eyed stage most of the eggs were transferred to the Duckabush substation to be hatched, and 75 per cent of the product was returned in the advanced fry stage for liberation in the slough. From the eggs retained at the station 1,040,000 advanced fry were produced. For the first time since fish-cultural work was undertaken at Brinnon a small collection of silver-salmon eggs was obtained. The run of this species is believed to be the direct result of annual plants of young salmon made by the bureau in the slough in recent years.

QUILCENE (WASH.) SUBSTATION.

The early run of chum salmon in the Quilcene River was above the average of the past three years. The second run was also large, though most of the fish escaped, as the trap was rendered ineffective by the prevailing high-water stages. The spawning season of this species began on August 17 and terminated December 20, with a total collection of 7,488,000 eggs, this number exceeding by nearly half a million the collection of the previous year. After the resulting fry had reached the free swimming stage they were transferred, in accordance with the usual custom, to ponds from which the screens had been removed and allowed to pass out at will. As a rule the fish leave these ponds in from four to six weeks' time.

Silver-salmon eggs to the number of 565,000, secured between October 17 and March 29, represent only about 20 per cent of the season's run of that species in the Quilcene River, most of the fish ascending during high-water periods and escaping the traps. Steelhead eggs to the number of 83,400 in the Quilcene hatchery at the opening of the year were developed to the No. 1 fingerling stage and released in Hood Canal. The spring collection of steelhead eggs, made between February 27 and June 7, and amounting to 745,000, was the largest in the history of the station. All fish taken in connection with this work were green at the time of capture and were therefore transferred to station ponds for the complete development of their eggs. Some of the eggs taken were shipped in the eyed stage to eastern hatcheries; the product from the remainder will be returned to parent waters.

In the course of the year a water-supply system for domestic use and fire protection was provided for this substation. A supply tank was installed on the hill opposite to and 55 feet above the foreman's cottage and was supplied with water from the creek by a hydraulic ram. From the tank the water is piped to the various buildings on the reservation.

SULTAN (WASH.) SUBSTATION.

This hatchery was open the entire year, and its work included operations with the chinook and silver salmons and the steelhead. All fry hatched are transferred in the yolk-sac stage to temporary ponds, formed by damming the overflow from the hatchery at various points. Here they may remain or pass out at will, no screens obstructing the outlets. Egg collections of the chinook salmon depend almost entirely upon the water stages in Elwell Creek. If the creek is low in September and October, very few fish can enter; but in the case of normal water stages good collections may be expected. As the former condition prevailed in the fall of 1921, the number of eggs taken was below the average, amounting to only 155,000. Approximately 100,000 silver-salmon fingerlings No. 1 carried over from the previous year were liberated in the creek during July. Egg collections of this species to the number of 2,304,000 were made at intervals from October 20 to March 13, hatched with only normal losses, and the resulting fry distributed in local waters tributary to the Skyhomish River. In July and August 104,400

FIG. 1.—Bureau of Fisheries salmon hatchery at Quilcene, Wash., with rearing ponds in foreground.

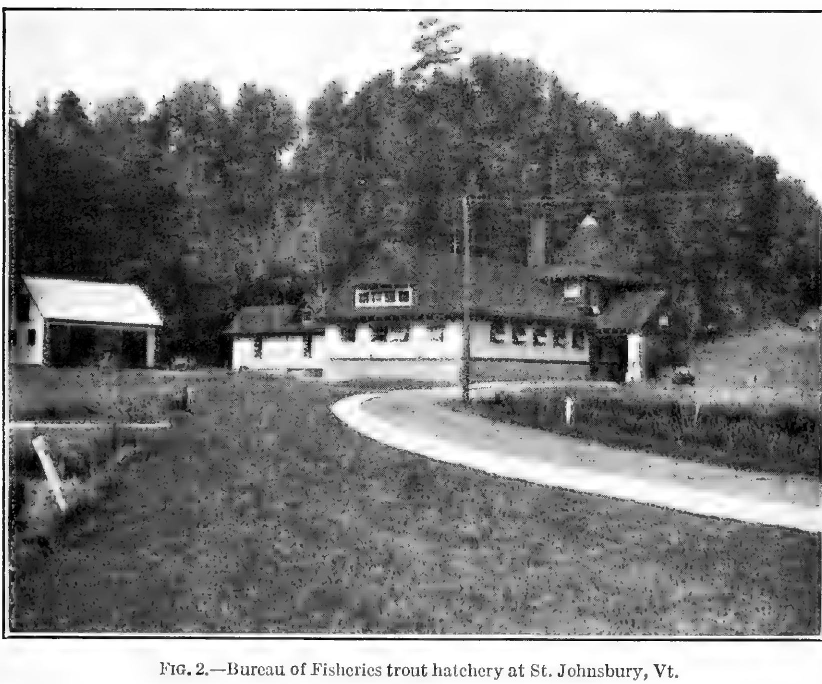

FIG. 2.—Bureau of Fisheries trout hatchery at St. Johnsbury, Vt.

young steelheads on hand were released in Elwell Creek, and during the succeeding spring 215,000 eggs of that species were collected, the spawning operations extending from April 1 to June 2.

QUINAULT (WASH.) SUBSTATION.

The usual summer operations for the rescue of fish from drying streams of the region had to be omitted, owing to pressure of other work. The first sockeye-salmon eggs of the season were taken October 25, and a day or two afterwards a heavy rainstorm flooded the trap, tearing out two sections of the rack and liberating most of the impounded salmon. Before water conditions again became normal another storm of even greater severity flooded the Quinault River and surrounding streams a second time, putting an end to collections for the season, the last eggs being obtained on December 20. Of the 4,100,000 secured approximately one-third were taken from streams other than Big Creek, which has heretofore been one of the principal sources of egg supply for the Quinault hatchery. Nearly 750,000 eggs were taken from fish caught in a small trap in one of the minor creeks near the hatchery, and a much larger percentage than usual was obtained from several of the smaller tributaries of Quinault Lake and Upper Quinault River. Two of these streams that had been racked for several years without any material results were this year filled with brood salmon. A point of interest is the extremely large proportion of small male fish everywhere present in the run.

In connection with the sockeye operations 2,050,000 silver-salmon eggs were taken, constituting the largest collection of that species since 1918. It is believed the run of silver salmon exceeded the large run of last year, but that most of the fish continued up the main river to their natural spawning grounds. On several occasions during the run of this species efficient work was possible with dip nets, and at one time two men were kept busy throughout the night in dipping operations. In an effort to reduce the considerable loss of silver-salmon eggs incident to transportation heretofore experienced a portion of the spawn was delivered to the hatchery in the milt, but without any discernible improvement.

During the early half of November 50,000 eggs of the chinook salmon were taken, this collection being nearly 100 per cent greater than that of last season. It has been observed that the main portion of the run of this species entering the mouth of the lower Quinault River spawn before reaching the lake, and during the time that sockeye spawn is being taken very few chinooks are in evidence.

The eggs and fish of the various species were handled in accordance with the methods that have been successfully employed in previous years. Owing to the clear, cold weather prevailing, the incubation period of all species was considerably prolonged. That of the sockeye salmon consumed 140 days, or 30 days in excess of the time required under more normal temperatures, while the hatching of the chinook and silver-salmon eggs was delayed 15 days beyond the usual time. As in former years, the fry were transferred to outside ponds on reaching the swimming stage and were held and fed until the

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development of younger lots necessitated their liberation. At the end of the year nearly a million sockeye fingerlings were on hand, it being the intention to hold them for liberation about August 1, providing water facilities permit.

In view of the criticism to which the work of this substation has been subjected from certain sources, it may be of passing interest to estimate the proportion of the total run of sockeyes that came under artificial propagation during the season by escaping the commercial fishing activities in the Quinault River and passing into Quinault Lake, where they were available for reproduction. It was the original plan not to conduct fish-cultural operations during the fiscal year 1921, but to obtain an accurate count of the sockeyes entering the lake to afford a comparison of the results of artificial propagation as against natural reproduction. As a result of certain defects in the counting weir as installed the exact number of sockeyes entering the lake could not be ascertained, and the figures are based to some extent upon estimate. Although no actual count of the fish spawned in connection with egg collections for the hatchery was made the data available are sufficient to afford a reasonably accurate estimate.

The number of sockeye salmon counted into Quinault Lake from April 14 to June 10, 1921, was 11,788. From June 10 to the end of the run it was estimated that 8,000 additional fish entered the lake, bringing the total run for the season up to 20,000 fish, in round numbers. Assuming that half of these were females, and placing at 2,000 the number of eggs produced by each female, there would have been available some 20,000,000 eggs. Comparing this with the number of eggs actually obtained for artificial propagation—4,100,000—it would appear that only about 20 per cent of the total number of spawning fish entering the lake came under artificial propagation; and though high water and storms interfered with the work to a considerable extent the conditions prevailing throughout the egg-collecting period may be said to represent an average season.

Since the efforts to obtain an accurate count of the sockeye salmon entering the lake in 1921 were not successful, profiting by the experience gained, the necessary alterations in the weir were made in advance of the season. The counting of the 1922 run of fish commenced on March 29, and the daily tally from that date to June 30 is given in the following tabular statement:

Daily count of sockeye salmon entering Quinault (Wash.) Lake during the fiscal year 1922, showing number of fish marked by gill nets each day.

Date.	Number of fish. Total counted.	Number of fish. Marked by gill nets.	Date.	Number of fish. Total counted.	Number of fish. Marked by gill nets.	Date.	Number of fish. Total counted.	Number of fish. Marked by gill nets.
Mar. 29	65		Apr. 7	194		Apr. 16	171	14
30	42		8	483		17	130	17
31	185		9	197		18	139	12
Apr. 1	200		10	91	4	19	125	18
2	188		11	122	6	20	143	18
3	349		12	60	4	21	174	27
4	591		13	97	5	22	159	23
5	860		14	190	15	23	177	22
6	316		15	147	12	24	187	27

Daily count of sockeye salmon entering Quinault (Wash.) Lake during the fiscal year 1922, showing number of fish marked by gill nets each day—Continued.

Date.	Number of fish.		Date.	Number of fish.		Date.	Number of fish.	
	Total counted.	Marked by gill nets.		Total counted.	Marked by gill nets.		Total counted.	Marked by gill nets.
Apr. 25	218	27	May 18	2,341	195	June 10	3,918	314
26	130	27	19	432	37	11	4,114	639
27	243	42	20	1,175	204	12	4,272	622
28	289	36	21	1,056	144	13	13,987	1,497
29	410	44	22	996	168	14	8,738	783
30	250	48	23	3,571	525	15	7,109	728
May 1	173	33	24	3,403	217	16	5,650	597
2	358	57	25	3,996	288	17	2,327	140
3	870	163	26	2,334	180	18	1,336	48
4	1,039	98	27	2,351	365	19	1,202	44
5	1,323	143	28	5,512	469	20	841	34
6	901	78	29	5,261	269	21	1,258	33
7	922	107	30	9,569	854	22	781	78
8	216	37	31	17,840	1,500	23	765	39
9	1,106	147	June 1	8,649	721	24	709	25
10	1,868	139	2	4,812	287	25	910	26
11	1,200	99	3	3,047	321	26	1,699	40
12	996	63	4	5,262	283	27	1,328	33
13	874	95	5	4,051	281	28	1,457	22
14	719	43	6	9,189	1,199	29	1,094	15
15	1,111	62	7	6,238	566	30	2,292	25
16	1,201	127	8	4,206	368			
17	1,896	184	9	4,316	389	Total	199,489	17,735

An interesting point developed in connection with the count, and one suggesting the desirability of a change in the existing regulations governing fishing in the Quinault River, is the very large number of fish showing gill-net marks. The numbers thus marked, representing approximately 9 per cent of the total count, are indicated in the table. The abrasions were of such a nature that it seemed certain that fully 50 per cent of the fish could not survive to the spawning period. In fact, every day during the latter part of the run considerable numbers of dead fish were removed from the upper side of the weir and many others were observed along the shores of the lake. These dead fish led to some criticism of the counting work, certain uninformed persons believing that the fish received their injuries at the weir. From the information at hand it appears that the trouble arose from the practice of setting gill nets of too large mesh in the mouth of the river, where the fish previously enmeshed are drawn through the nets by the strong current on the ebb tide and the motion of the sea on the bar. It is alleged that many of the fish thus injured fall prey to seals, while others, evading the nets on the second entry to the river, reach the lake in the condition described. With the view of obviating the resulting heavy wastage it was proposed to dispose of these gill-net marked fish through the Indian Service, but so many objections were raised against the project by Indians and fish buyers of the region that the plan was abandoned.

It is conceded by most observers that the run of sockeye salmon during the season equaled the large run of 1915. All of the Indians engaged in fishing made excellent catches and received large monetary returns. During the peak of the run Indians using dip nets

were able to take as many as 300 fish per day, while those operating gill nets received from $200 to $300 per day for their catches. A uniform price of 50 cents per fish regardless of size was paid by the buyers throughout the season.

CLACKAMAS (OREG.) STATION AND SUBSTATIONS.

[HUGH C. MITCHELL, Superintendent.]

Though fish-cultural operations in the Oregon field were materially handicapped at several points by high water and loss of racks during the spawning season, the general outcome of the year's work is regarded as satisfactory. Both the spring and fall runs of chinook salmon were equal to expectations throughout the field, except on the Rogue River and in Idaho on the Lemhi. The egg collections at Clackamas and its nine substations amounted to 63,685,850, of which 57,885,100 were chinook salmon. This makes a favorable comparison with last year's total of 42,912,000 eggs taken at all points. Young salmon to the number of 51,446,800 were retained for rearing at the various hatcheries, but at several points the stock held was found to tax the existing facilities too heavily for the best results and considerable numbers were of necessity liberated when only from 1 inch to 1.5 inches long. Aside from these rather premature plantings rearing and feeding operations were carried to a successful conclusion, the losses being normal and all fish released in a healthy condition. The usual quantities of salted salmon were prepared at all points for fish food.

CLACKAMAS (OREG.) STATION.

At Clackamas station, where chinook-salmon eggs are secured under contract, fishing and spawning operations began on September 19 and continued to October 28, when a sudden rise in the river permitted all fish held below the racks to escape, putting an end to the season. The egg collections numbered 7,636,800, and it is estimated that they might have been increased by at least 25 per cent had it been possible to hold the fish two or three weeks longer. With the exception of two days at the most critical period, the eggs in the hatchery were carefully picked over daily, regardless of the stage of development. It appeared that the loss of eggs was lessened and the quality of the fry improved by this method. In addition to the salmon eggs secured locally, several shipments forwarded from the Little White Salmon and the Sandy River stations were received and cared for.

As a result of some tests made, with the view of determining the proper amount of food to be given young salmon, it seems probable that a given number of fish can be successfully carried on a smaller quantity than has heretofore been deemed essential at this station. The experiments also seemed to indicate that the young fish receiving food twice each day made as rapid growth as those receiving nourishment four and six times daily and were equal to them in other respects. The essential requirement in using the smaller amount appears to be that the food must be supplied slowly and distributed in the troughs evenly in small amounts at each feeding.

Fish thus treated showed no signs of "nipping," which is an indication of insufficient food and is frequently troublesome in trough-fed fish.

Transfers of eggs of other species to Clackamas station included a consignment of 50,000 black-spotted-trout eggs from the Yellowstone National Park; 400,000 brook-trout eggs from Springville, Utah; and 50,000 rainbow-trout eggs from the Madison Valley (Mont.) field. The fry resulting from all these were on hand at the close of the year.

UPPER CLACKAMAS (OREG.) SUBSTATION.

On the Upper Clackamas River, where fishing and spawning operations were conducted from August 23 to September 13, the results in eggs collected did not equal those of last season, owing to a lighter run of fish and to illegal fishing. Eggs to the number of 841,300 were secured, and these, together with 1,450,000 eyed eggs forwarded from the Little White Salmon hatchery, produced 2,111,000 fingerling salmon for liberation in local waters. There was at no time any extraordinary loss of either fish or eggs, though once during January the water was suddenly reduced and the hatchery had to be operated on a minimum supply for a period of four and one-half hours. Taken as a whole, the season was a very satisfactory one, aside from the fact that liberations of stock had to be made from time to time at an earlier period than was desirable, in order to relieve congestion. In future the retaining rack at this station will be installed 500 yards farther downstream than heretofore, with the view of including an existing eddy within the inclosure as a place of rest and protection for spawning salmon. It is anticipated also that the take of eggs will be somewhat increased by this change.

LITTLE WHITE SALMON (WASH.) SUBSTATION.

In the face of a light run of salmon and a pack slightly below the average, it is gratifying to report that brood salmon in unusual numbers made their appearance at the bureau's stations on the Columbia River and all conditions during the fishing season were favorable. Eggs were taken on the Little White Salmon River from September 19 to October 20, amounting to 33,641,000. Soon after the close of the spawning season a severe storm broke, filling the watercourses with coarse hail and converting the streams into ice packs. One flume was carried away by a snow and hail slide, and later on the main flume ceased to function temporarily, being pushed out of line and otherwise damaged. However, through the exercise of intelligent and persistent effort the small flume was replaced during the night and the main one patched to serve out the season, though the entire system will have to be extensively repaired in advance of next season's operations. The roads were blocked for months after the storm, rendering inoperative to some extent the plan of relieving congestion in the hatchery by the transfer of eggs to other units. For this reason more fish were produced than the available space would accommodate, and though all of them were fed for a time a considerable number had to be released in the No. 1½

fingerling stage. The moderately even cold weather prevailing throughout the winter kept the water temperature at a low point, retarding development and growth of the fish and probably lowering the average size of the salmon liberated as compared with last year's output. Eyed eggs to the number of 6,650,000 were transferred to the Clackamas station and to Big White Salmon and Upper Clackamas substations, and 1,400,000 were furnished to the Oregon and Montana State fisheries departments.

Excavations made in advance of the season for four large race ways on the flat at the west of the lower hatchery proved so eminently suited to the work of holding young salmon that a plan for replacing the entire pond system by roughly excavated raceways is now being considered. During the season the fish in the station inclosure were closely inspected by one of the most expert buyers on the Columbia River, who pronounced them spring-run chinooks and not fall fish.

BIG WHITE SALMON (WASH.) SUBSTATION.

During the spawning season, extending from September 3 to October 12, 12,025,000 chinook-salmon eggs were taken, 8,000,000 of them being secured from fish entering Spring Creek fishway. The establishment of this excellent run of salmon in Spring Creek, which shows an annual increase, is of interest since that tributary was not a natural salmon stream, the present runs being the result of fingerling fish introduced therein from the Big White Salmon hatchery. This stream is of further interest, since it is affording a convenient source of salmon eggs for the hatchery. The Big White Salmon is a difficult stream in which to conduct operations, being deep and swift and offering every chance for fish to evade the seines. During the winter of 1921–22 the fishway in Spring Creek was extended, making it less difficult for the fish to enter.

Departing from the usual custom of stripping at the fishing grounds the salmon taken in the Big White Salmon River, such fish during the past season were killed at the trap and hauled to the hatchery before taking the eggs. By this means the transfer of eggs down the Columbia River in skiffs, with the consequent heavy losses during the heavy seas often prevailing, is obviated.

Through the transfer of eyed eggs from the Little White Salmon substation the stock was increased to 15,625,000, which were hatched with merely nominal losses. The resulting fry were placed in Spring and Hatchery Creeks and fed until they were from 2 to 3 inches in length. This is the first season that Hatchery Creek has been so utilized. The results were such as to warrant a continuance of this method of feeding.

ROGUE RIVER (OREG.) SUBSTATION.

Much difficulty was experienced in connection with the installation of racks at this point, the equipment being carried away twice by freshets from melting snows during the early summer. The work of replacing them for the third time was completed on August 12, on which date fishing and spawning operations were undertaken and

continued daily until October. The total collection of chinook-salmon eggs for the season amounted to 1,665,000, which is considered satisfactory in view of the conditions referred to above. The run of silver salmon in all tributaries of the Rogue was light, and from collecting operations conducted at Elk Creek Dam only 94,500 eggs were realized. The steelhead work at this point included the rearing and liberation in local waters of some 100,000 fingerling fish produced from eggs obtained the previous year and the collection of 347,500 eggs between February 17 and May 15. Eggs of this species to the number of 1,943,000, transferred from the Applegate Creek field, were also hatched, and the resulting fry are being reared to the fingerling stage.

It is evident that a considerable number of the spawning steelheads escape over the Low Elk Creek Dam, and as it is impossible to increase its height without endangering the county road an effort will be made to overcome the difficulty by adding an apron to the dam during the coming summer when the stream is at a low stage.

A serious wind and rain storm passing over southern Oregon in November damaged both current wheels to such an extent that the station water supply was entirely cut off for two days, necessitating the immediate liberation of all fish on hand. The eggs in the hatchery were saved by holding them in a hastily constructed temporary battery on the west side of Elk Creek until repairs could be made. In preparation for fish-cultural operations during the succeeding year the rack was reconstructed across the Rogue River in April and washed out by a freshet the following month. It was replaced in June, and at the end of the year a sufficient number of chinook salmon were in evidence below it to produce a normal season's egg collection.

APPLEGATE CREEK (OREG.) SUBSTATION.

Fish-cultural work at this point was confined to the propagation of silver salmon and steelheads. During the spawning season of the former, extending from November 29 to January 7, the water stages were low and the weather cold. Consequently, only a few fish made their appearance and the egg collections were light, the total being only 113,000.

Because of its ineffectiveness during the past three years, the fin rack used at this point was converted in advance of the steelhead spawning period into a solid dam. The racks were removed, and after reinforcing three of the piers the spaces were spanned by heavy timbers and logged, this change necessitating the raising of the wings 12 inches. This somewhat extensive improvement was made at a comparatively light cost, and although a number of steelhead trout succeeded in their efforts to surmount it, it is believed this may be prevented in future by the construction of an apron to break the direct fall of water. Steelheads are fish of a most persistent nature. Arriving as they do when the rivers are high, they are very difficult to capture, and unless the obstruction encountered is absolutely fish proof they will effect their escape. Numbers of them were seen surmounting the dam the past season, though the obstruction was 8 feet high, and the nearly perpendicular stream of water falling over it was more than 16 inches in its smallest dimension.

Egg collections of the steelhead trout were made from February 24 to May 8. There was a good run of fish, notwithstanding the somewhat unfavorable climatic conditions prevailing, and 3,673,000 eggs were secured. After developing them to the eyed stage nearly 2,000,000 were transferred to the Rogue River substation for incubation, and shipments comprising a total of 200,000 were furnished to the State fishery departments of New York, Minnesota, and Pennsylvania, and to the bureau's Bozeman (Mont.) station. The remainder were hatched, with the view of rearing the resulting fish to the fingerling stage for distribution in the parent waters.

SANDY RIVER (OREG.) SUBSTATION.

With the view of determining the fish-cultural value of this field, operations were undertaken late in July at the abandoned State hatchery, located below the hydroelectric dam on the Sandy River, near Marmot, Oreg. A rack was hastily thrown across the river to intercept the fish still running, and chinook-salmon eggs to the number of 1,637,000 were obtained between August 18 and September 10. These were held until eyed, the losses being unusually heavy because of an inadequate water supply, and were then transported to the Clackamas station to be hatched. While the work with the chinook salmon was still in progress a heavy run of silver salmon was observed, but, as no preparations had been made for work with that species, egg collections could not be undertaken, and the substation was closed for the season on October 1. In the month of March an employee was stationed at Sandy River to determine the size of the run of steelheads and black-spotted trout, and incidentally, at little expense, he obtained 634,000 steelhead eggs.

With the experience gained the advisability of conducting operations at this location is no longer questioned, and preparations for the improvement of the hatchery and the proper handling of the stock will be started next season in due time.

SALMON (IDAHO) SUBSTATION.

The importance of the Salmon River region in connection with the valuable commercial fishes of the Columbia River Basin having been recognized from the experience gained in the fish-cultural work of past years and the more recent investigations, it was decided to develop fish-cultural operations there and not confine the work to egg collections only. The Salmon River with its tributaries and the beautiful glacial lakes that they drain constitutes a most important natural nursery for salmon and trout. On account of its rugged topography, inaccessibility, and lack of agricultural land much of this territory, and particularly the portion that is drained by the South Fork and the Middle Fork of Salmon River, lying within the Idaho and Payette National Forests, will probably remain undeveloped for a long period, though a highway follows through the canyon of the main branch of the Salmon River from Shoup to Stanley, a distance of 150 miles. Because of the splendid spawning areas available, in addition to the advantages mentioned above, it would seem that some measure of protection against the unsportsmanlike methods pursued by many, of spearing and otherwise dis-

turbing the fish on the spawning beds, would meet the immediate requirements in conserving fish in these waters without resorting to artificial propagation. However, conditions on the main branch of the river are different. In that section irrigation ditches are numerous, the highway affords ready access to sportsmen, and the river and many of its tributaries are heavily fished.

During the year a hatchery building 32 by 90 feet, equipped with 60 hatching troughs, and a four-room cottage for the accommodation of the person in charge, were constructed on land near Salmon, Idaho. Title to this land is vested in the State of Oregon, and its control for fish-cultural purposes has been delegated to the bureau. The site is admirably suited to such work, an abundance of most excellent spring and creek water being readily available and affording ample opportunities for rearing ponds.

Egg collections of the early-run chinook salmon were made in Lemhi Creek, a tributary of the Snake River, during the latter part of August and transferred to the Salmon substation to be hatched. Because of the flooded condition of the creek the run of salmon was due before the rack could be installed, and it is felt that large numbers of fish passed upstream before the construction could be made fish tight. The spawning period extended from August 15 to September 2, and the total egg collections amounted to 440,000. In addition to the salmon eggs taken in Lemhi Creek, 50,000 rainbow-trout eggs were shipped from the Wyoming field and 150,000 eggs of the same species were received for incubation for the State of Idaho and the Salmon Rifle Club, of Salmon, Idaho. The fry resulting from all these eggs were on hand at the close of the year.

Though the Salmon hatchery was operated for the first time during the longest and coldest winter of which there is any record, the building and the water supply met all requirements and the eggs produced a high percentage of strong healthy fish for return to parent waters. This Idaho field is believed to have great possibilities, and plans are being made with the view of developing it into one of the principal fish-cultural factors in the Columbia River Basin. During the coming season racks will be built on the Lemhi and Pahsimeroi Creeks and a third eying station will be constructed at a suitable point on Sunbeam Dam.

WASHOUGAL RIVER (WASH.) SUBSTATION.

Late in March an employee was detailed to this field to make preliminary arrangements for the collection of steelhead eggs. The fishway was racked, springboards from which to dip the fish were suspended, and the retaining pens in which to hold the partially ripe fish were overhauled and launched. Eggs were taken throughout the month of May, the total aggregating 932,000. After developing them to the eyed stage, sufficient numbers to supply applicants were shipped. The remainder were incubated for local waters.

BAIRD (CALIF.) STATION AND SUBSTATIONS.

[W. K. HANCOCK, Superintendent.]

In this field, which is devoted exclusively to the propagation of the chinook salmon, natural conditions were very unfavorable for fish-cultural work. Owing to an unusually extended period of

drought the water stages in all streams were abnormally low, making it difficult for fish to ascend in considerable numbers. There being no run of salmon whatever in the McCloud River, on which the Baird Station is located, the hatchery at that point was stocked with eggs taken at the Battle Creek and Mill Creek substations, such transfers being necessarily postponed until after late fall rains had supplied sufficient water for the conduct of hatching operations. The first consignment of approximately 1,000,000 eggs from the Battle Creek substation was received on January 6, and shortly afterwards a second consignment of 500,000 from the Mill Creek collections was delivered. During the intense cold prevailing through midwinter the supply ditch could not be kept free of ice, and from January 19 to February 8 pumps had to be operated for maintaining a supply of water in the hatchery. Incubation was completed by March 6, and as soon as the fry had reached the proper age they were turned into several temporary ponds, formed by damming small streams in the vicinity of the station, and fed for a time on salted salmon, beef liver, and mush before being liberated in the McCloud River.

This station is very much in need of an adequate pond system for holding and feeding young salmon until they attain a desirable size before releasing in open waters. The present expedient of utilizing small stream inclosures for the purpose is unsatisfactory for several reasons, but principally because the streams become dry at the approach of summer, necessitating the liberation of the fish at an unsuitable stage of development. Adequate pond space is also greatly needed at the Battle Creek and Mill Creek substations. At the first-named point five earth ponds are available for holding salmon to the fingerling No. 2 stage, but at Mill Creek there is no pond system whatever and resort must be had to several shallow excavations in order to retain and feed a few hundred thousand fry for a limited period.

The spawning season at the Battle Creek and Mill Creek substations extended from October 22 to December 4, and a total of 6,363,000 eggs were taken. The work at both points was much below expectations, excessively low water stages seriously curtailing the results. After making the transfers of eyed eggs referred to above the product of the remaining eggs at these stations, in the form of fingerling fish, was returned to local waters.

GREAT LAKES FISHES.

Of no less importance than the work of the salmon hatcheries is that concerned with the fishes of the Great Lakes, and no line of fish culture has a more hearty indorsement of the interests involved. Without exception, as far as has been ascertained, the bureau's work in fish culture throughout the region has the unqualified indorsement of the fishing interest and of the individual fishermen, and in no section is this spirit of approbation manifested in the form of practical cooperation to a greater extent. A feature of the work that readily commends it to the practical fisherman is that all of the eggs incubated at these hatcheries are obtained from fish taken in the market fishery that otherwise become a total loss. During the fiscal year 1922 seven stations and substations on the Great Lakes and Lake

Champlain were operated with an aggregate output of about 1,040,000,000 eggs and fry of the commercial species. This figure includes the whitefish, cisco, lake trout, pike perch, yellow perch, and carp. Smaller numbers of brook trout, rainbow trout, and small-mouthed black bass were also produced, as indicated in the table on page 12. The output of these stations for 1922 is smaller by approximately 120,000,000 than in 1921, the principal difference appearing in the output of pike perch. The yellow perch was propagated also at the Bryans Point (Md.) substation.

DULUTH (MINN.) STATION.

[S. P. Wires, Superintendent.]

Lake-trout egg collections were made at various points on the south shore of Lake Superior and at favorable points along Isle Royal as in previous years. The spawning season opened at Washington Harbor, Isle Royal, on September 25, and closed there about November 15, the collections at all stations being about 22,250,000. All of these were incubated at the station except 1,000,000 that were delivered to the Minnesota State hatchery, located at French River. Unfavorable weather conditions which prevailed for a time during the height of the spawning season resulted in an egg collection somewhat below the average in quality, but entirely satisfactory otherwise. The resulting eyed eggs, fry, and fingerlings were in excellent condition when delivered to messengers for distribution.

A total collection of 22,500,000 whitefish eggs from the Put in Bay collecting field were received, and nearly 4,000,000 more were purchased from Isle Royal fishermen at 40 cents per quart. The egg-collecting period of this species extended from October 25 to November 10, and, as in the case of the lake trout, much unfavorable weather prevailed during almost the entire spawning period. However, the quality of the eggs as a whole was fairly good, the greatest loss occurring from one lot of about 4,250,000 produced by the field station at Toledo, Ohio. The loss sustained from this particular lot was a factor, of course, in reducing the percentage of hatch among the whitefish eggs. The percentage of hatch of lake trout was about 56 and of whitefish about 66.

Because of a lack of funds pike-perch propagation was not undertaken in Minnesota waters as has been customary, and of the limited collection of eggs of the species in other fields none were available for transfer. Eyed brook-trout eggs to the number of 150,000, procured by purchase from commercial hatcheries, were hatched with only ordinary loss (about 5 per cent) and 100,000 rainbow-trout eggs that were transferred from the Bozeman (Mont.) station were hatched with a loss of less than 4 per cent. At the end of the fiscal year 90,000 fingerling rainbow trout No. 1 were on hand for distribution.

NORTHVILLE (MICH.) STATION AND SUBSTATIONS.

[W. W. Thayer, Superintendent.]

NORTHVILLE (MICH.) STATION.

From the stock of small-mouthed black bass carried over from the previous year some 21,000 fingerlings No. 3 were distributed, and the hatch of this species for the fiscal year 1922 was estimated at 200,000.

The brood stock received from Lake Erie wintered in excellent condition and was held in the wintering ponds until there was evidence of nest preparation. Spawning commenced almost immediately after transfer to the spawning ponds, and the first fry were observed on May 22, some 12 days after the first nest building was observed, the mean water temperature being about 60° F. Eggs and fry were observed in the ponds as late as June 1. Distribution was undertaken as soon as the young fish had reached the feeding stage, and by June 7 fingerlings No. 1 from the current year's hatch were available. The young small-mouthed black bass make excellent growth in the ponds at this station, and examples of fish 3½ inches long when 3 weeks old are not uncommon. There were received from the Michigan commission 103,000 rainbow-trout eggs, from which a hatch of 94 per cent was obtained, the fry and fingerlings resulting from these entering into the general distribution in the States of Michigan, Indiana, and Illinois.

CHARLEVOIX (MICH.) SUBSTATION.

Lake-trout egg collections were undertaken at the usual points on Lakes Michigan and Huron, the collecting season extending from November 1 to 25. The work yielded 44,000,000 eggs, as against 30,876,000 for the previous year. The weather conditions were generally favorable, and fishermen at most points secured satisfactory numbers of fish. The quality of the eggs taken was, however, unsatisfactory, and less than 50 per cent produced fry.

There was no important change in the unsatisfactory fishing regulations in force last season, and to this condition the poor results of the season's work both as to quantity and quality of the eggs obtained must be attributed. Whitefish eggs to the number of 46,080,000 were obtained, a satisfactory increase over the 12,080,000 taken in the same fields during the year previous. This number does not represent the full possibilities of the fields for egg collections when suitable changes in the fishing regulations become effective and funds are available for certain changes in the methods at present employed in egg collections. The collecting season extended from November 1 to December 4 and covered the usual points on Lakes Michigan and Huron, most of the eggs coming from fields in the vicinity of Alpena. The local collections were augmented by transfers from Lake Ontario and Lake Erie fields, amounting in the aggregate to approximately 50,000,000.

In addition to the lake trout and whitefish, 20,000 eggs of the steelhead from the Birdsview (Wash.) substation were incubated and the resulting fry planted in a tributary of Pine Lake.

ALPENA (MICH.) SUBSTATION.

Though this substation is located on one of the most important fishing ports of the Great Lakes, no fish-cultural operations have been attempted for several years because of the unsatisfactory nature of the water available for the hatchery. During the fall of 1922 it was decided to give this water a further trial as to its suitability for fish-cultural purposes. Accordingly, 1,500,000 lake-trout eggs and 6,000,000 whitefish eggs were forwarded in the eyed stage from the

Charlevoix station. The results of this experiment prove conclusively that the water now available at the station is not suitable for fish culture. While the lake trout seemed more resistant to the chlorinated water than the whitefish, the loss on this species was nevertheless serious.

BAY CITY (MICH.) SUBSTATION.

Pike-perch culture was again undertaken on Saginaw Bay at Bay City, Mich., and the necessary force of men was assembled on April 1. Conditions seemed normal in every respect, and the usual satisfactory collection of eggs was anticipated. The first eggs were taken on April 10, and between that date and the 18th practically the total number of 75,450,000 eggs was obtained. A violent storm occurring on the 18th and continuing for several days brought all fishing operations to an abrupt end, and the station was closed on the 25th. Most of the eggs were delivered to the Detroit hatchery of the Michigan Fish Commission, and smaller numbers were furnished to the Conservation Commissions of Indiana and Iowa. The importance of the work that may be done in Saginaw Bay in connection with the valuable pike-perch fishery and the desirability of a properly equipped station conveniently located for the incubation of the eggs available is again mentioned.

PUT IN BAY (OHIO) STATION.

[S. W. DOWNING, Superintendent.]

The egg collections at this station for the fiscal year 1922 aggregated 690,730,000, an increase of 128,305,000 over the year previous. The eggs were divided among the species as follows: Whitefish, 385,820,000; pike-perch, 149,980,000; yellow perch, 56,930,000; and carp, 98,000,000. Although the work addressed to the whitefish produced entirely satisfactory results, it is of interest to note the decline of the work in certain sections of Lake Erie.

In the Toledo (Ohio) field, which includes the principal fisheries from the mouth of the Detroit River down the south shore of the lake as far as Wards Canal and Turtle Creek, midway between Toledo and Port Clinton, there were produced only 16,060,000 eggs, and none whatever were obtained from the Monroe (Mich.) fields. Previous to the fiscal year 1921 these two fields yielded each year between 50,000,000 and 70,000,000 eggs. Whether or not this sudden decline in a profitable fishery is due, as many persons interested are inclined to think, to the increased volume of pollution from recently established industrial plants at Monroe, Mich., and Toledo, Ohio, the bureau is not prepared to say, but it is significant that at other points free from such possible influences a decline is not apparent. The egg-collecting season extended from November 11 to December 12, eggs being obtained from Toledo, Port Clinton, Catawba Island, North Bass Island, Middle Bass Island, and Put in Bay, all in Ohio. Of the total collection, some 98,000,000 were shipped in the green stage to other stations and about 28,000,000 were planted on the spawning grounds immediately after fertilization. These plants represented eggs of poorer quality and were necessary to provide space in the hatchery for the better eggs. The

remaining 260,000,000 were eyed by December 30. Six million of these were shipped to other stations, and 204,000,000 fry were hatched and liberated in Lake Erie within a range of 2 to 15 miles from the hatchery.

Acceding to the demands of local fishermen, the work addressed to the propagation of the carp on the Portage River and Sandusky Bay was again taken up. Owing to rough weather the spawning season opened late, but it continued correspondingly late, with very satisfactory results, the egg collections amounting to 98,000,000. All fry hatched from these eggs were deposited in the Portage River between Port Clinton and Oak Harbor, over a distance of about 12 miles.

With the advent of an early spring conditions were favorable for the spring fishing on Lake Erie on March 15, the first day of the open season, and good catches of fish were made from the beginning, a very fair per cent of them being pike perch. However, no ripe fish were observed until April 4, between which date and May 4 pike-perch eggs to the number of 149,980,000 were collected from the fisheries at Toledo, Port Clinton, and North Bass Island. Of these approximately 50,000,000 were eyed and 8,275,000 shipped to other stations. The Ohio State hatchery at Put in Bay turned over to the bureau 3,500,000 eyed eggs, and from the combined stock 46,000,000 fry were produced, of which 40,000,000 were released on the spawning grounds in Lake Erie and 6,000,000 were furnished to applicants in Indiana, Pennsylvania, and Ohio.

The spawning season of the yellow perch corresponds closely with that of the pike perch in Lake Erie, and fishermen operating for the latter were requested to save all available eggs. As a result of their efforts 56,930,000 yellow-perch eggs were secured between April 20 and May 4, of which small numbers were shipped to the Kansas fisheries department and to Washington, D. C., for exhibit. Because of the peculiar nature of eggs of this species, and the usual turbidity of the water supply in the Put in Bay hatchery during the spring, it is difficult to carry the eggs beyond the eyed stage in hatching jars. Therefore, after successfully eying them, a large number were planted on the spawning grounds and the remainder were incubated in wire baskets suspended in the bay adjacent to the hatchery. This method of incubating yellow-perch eggs has been extensively followed on the Potomac River and has given uniform satisfaction.

CAPE VINCENT (N. Y.) STATION.

[J. P. SNYDER, Superintendent.]

The repairs and alterations under way at this station were practically completed. During the year an 80-horsepower Almy water-tube boiler, with all necessary accessories, was installed, thus equipping the station to supply its own hatchery water independently of the city water, which has been used in the past. Two new batteries of 396 hatching jars each were set up, giving the hatchery a capacity for incubating approximately 275,000,000 whitefish or 587,000,000 cisco eggs.

Besides making whitefish-egg collections in the usual fields near Cape Vincent, the cooperative arrangement with Canadian au-

thorities was continued, whereby the bureau's spawn takers are allowed to collect whitefish and cisco eggs in certain Canadian waters of Lake Ontario. Because of the worthless conditions of the boats available, the attempt to collect eggs in the Bay of Quinte was a failure. This is merely a repetition of former years' experience, and it further demonstrates the necessity of having a suitable boat in order to successfully cover this important field. From all fields an aggregate of 187,420,000 whitefish eggs were secured, of which 126,-349,000 were shipped, in the green stage, to Canada, to New York and Pennsylvania State hatcheries, and to the bureau's substation at Charlevoix, Mich., and central station at Washington, D. C.

Many eggs taken and fertilized by fishermen were not secured, for the reason mentioned (the worthless condition of available boats), and for the same reason some 170,000,000 eggs taken by the bureau's spawn takers were planted on the spawning grounds. Of the eggs retained at the hatchery 507,500 in the eyed stage were shipped to applicants, and the 31,500,000 fry resulting from the remainder were distributed in Lake Ontario, as were also the fry produced from the eggs furnished the New York and Canadian hatcheries. Among the whitefish eggs received from Canadian waters were 2,000,000 taken from fish caught and held in pound nets. These were secured under unusually favorable conditions, and 70 per cent of them were successfully incubated. Cisco eggs were taken in practically the same waters in which the whitefish operations were conducted, but with Sodus Bay and Fairhaven Bay, N. Y., in addition, the total from all points amounted to 429,900,000. Of these 212,190,000 were planted as green eggs in public waters, or apportioned among the hatcheries of Pennsylvania, New York, Maryland, and Michigan; 5,000,000 eyed eggs were delivered to the Michigan Commission, and fry to the number of 47,400,000 were hatched and planted in Lake Ontario. Acting with the consent and advice of the New York Conservation Commission, pound nets were set in Henderson Bay, with the view of ascertaining the possibility of obtaining eggs from waters closed to commercial fishing, but the results were negative.

Lake-trout eggs were collected at Pigeon Island, Ontario, and Stony Island, N. Y., as in former years, the total amounting to 818,000, from which a 71.7 per cent hatch resulted. Adult yellow perch were collected by the use of trap nets from the St. Lawrence River and carried in tanks in the hatchery until ready to deposit their eggs. From this source 11,655,000 eggs were obtained and incubated, and fry to the number of 10,000,000 were hatched and liberated in small bays along the river.

Brook trout and rainbow trout also entered into the distribution from this station, eggs of these species being obtained either by purchase or by transfer. Brook-trout eggs to the number of 360,889 were received from the bureau's Springville (Utah) station, and 288,000 were purchased from the Brookdale Trout Co., of Kingston, Mass. Owing to the development of fungus on the young fish, probably because of impurities in the water supply, the mortality was alarming for a time, but after immersing in a strong salt solution and transferring them to the village water-supply the disease disappeared.

SWANTON (VT.) SUBSTATION.

[A. H. DINSMORE, Superintendent.]

Fish-cultural work on Lake Champlain during the spring of 1922 was a dismal failure, because of the effects of the unprecedentedly high-water stages in the Missisquoi River and the lake. The Swanton station was opened March 30, and the first pike perch were taken on April 13. Almost immediately afterwards heavy rains and melting snow brought about flood conditions, abruptly ending all fishing operations. In all, 36,737,000 pike-perch eggs were secured. Following the close of this work 16,200,000 yellow-perch eggs were collected and successfully hatched.

BRYANS POINT (MD.) SUBSTATION

[L. G. HARRON, Superintendent.]

Most excellent results were obtained in connection with the work of propagating the yellow perch at this station. Between the 3d and 14th of March 21,620 adult fish of this species, ranging in length from 6 to 9 inches, were collected and placed in live boxes. Approximately 75 per cent of them were females, and in the course of the two weeks beginning March 14 they deposited naturally in the live boxes 199,660,000 eggs of fine quality. Some 6,250,000 were supplied to other stations of the bureau and to applicants. The remainder produced fry to the number of 168,102,000, all of which were distributed in the principal tributaries of the Potomac with the exception of 3,000,000, used in supplying applicants in Pennsylvania.

CONSIDERATIONS CONCERNING WORK OF GREAT LAKES STATIONS.

MORTALITY IN PIKE-PERCH EGGS.

Every fish-culturist whose work has brought him in contact with the incubation of pike-perch eggs is aware of the high percentage of loss almost invariably sustained, and most of them will doubtless agree that a 50 per cent hatch may be considered fairly successful. The subject has been the ground for several investigations, but no definite conclusions have ever been reached nor any practical remedies suggested. In the most recent report[3] on studies of this important point in fish culture, Dr. Franz Schrader and Sally Hughes Schrader conclude that the high death rate is not caused principally by lack of impregnation, as seems to have been generally supposed. They attribute the most important cause to the agency that manifests its presence in abnormalities occurring during the early stages of development, which must lead either to malformation or death. They believe that this agency may be traced to the practice of retaining captured fish in artificial inclosures, pending the maturity of the eggs and sperm; that the same condition may be induced in fishes retained for undue periods in the fishing appliance used in their capture; that the present methods, mechanical or otherwise, but ad-

[3] Mortality in Pike-Perch Eggs in Hatcheries. By Franz Schrader and Sally Hughes Schrader. Bureau of Fisheries Document No. 926, Appendix V, to the Report of the U. S. Commissioner of Fisheries for 1922. Washington, 1922.

mittedly crude, that are used to prevent cohesion are also responsible for a certain percentage of the mortality; and that extreme care in the stripping process and in the application of the means to overcome cohesion may reduce the loss to a considerable extent.

PROPER METHODS OF TAKING, FERTILIZING, AND CARING FOR EGGS OF WHITEFISH AND CISCO.

Every year an increasing number of fishermen undertake to secure for delivery at the hatcheries the mature eggs of the fish taken in their operations. In certain remote sections of the Great Lakes eggs that they are unable to deliver at a hatchery are taken and fertilized by fishermen. Every possible effort is made to furnish a boat or other means for transporting all eggs secured to the nearest hatchery, but with the limited facilities at present available it can not always be arranged to visit all points where eggs are available within a reasonable time, hence the fullest value of this cooperation is not always realized. As the value of eggs for artificial propagation depends to a considerable extent upon the methods used in obtaining, fertilizing, and caring for them prior to their installation in a hatchery, the following suggestions are offered for the advice of interested persons:

The prospective spawn taker should have a pan, a dipper, and a number of wooden kegs or cans in which to place the eggs after fertilizing them, these articles to be supplied from the nearest hatchery. As soon as spawning fish are available rinse and drain the pan, wipe the excess water and slime from a female fish by passing the hand gently over the abdomen. Hold the fish as close to the pan as possible and express the eggs from it by gentle pressure, working from just above the pectoral fins toward the vent. Eggs that are ripe and in condition for incubation will flow freely from the fish under slight pressure, and only such eggs as are obtainable without the use of force should be taken. After stripping the female the milt is expressed on the eggs by a similar manipulation of the male fish. To insure the contact of all eggs with the milt, they are gently stirred with the naked hand or by a careful movement of the pan.

The process of alternately stripping females and males is continued, with frequent stirring, until the pan is about half full, when the contents are carefully transferred to a transportation can or a keg, which has been previously half filled with water. In making the transfer do not subject the eggs to the drop incident to pouring, but lower the pan into the water before emptying. If this is impracticable, the same result may be accomplished with the dipper. As the eggs increase nearly 100 per cent in size shortly after fertilization, no more of the newly taken eggs than will fill the keg one-quarter full should be placed therein. If more than this amount is placed in the keg, loss of eggs from suffocation will result, as the eggs attain the greater part of their increase in size during the water-hardening process. As the eggs at this time have a strong cohesive tendency, it is necessary to agitate them at frequent intervals by stirring gently with the hand.

As soon as all eggs available for the day have been taken those on hand should be washed. This is done by pouring off and renew-

ing the water in the keg or can until all milt and sediment is washed out and the water on the eggs is clear. After washing, the cans should be filled with water and the eggs carefully watched. If the eggs show any tendency toward cohesion, they must be thoroughly agitated by carefully stirring with the hand. This precaution is to be taken throughout the time the eggs are in the possession of the spawn taker, and the water in the cans must be changed at least once an hour. Eggs taken from fish that have been in the nets more than 24 hours are seldom good, though the fish apparently may be in good condition. Eggs from dead fish are of no value. When changing the water on the eggs, or during the washing process, do not pour water directly on them, but lower the dipper into the container before emptying or pour the water against its sides. The more carefully the operations outlined are performed the greater the percentage of fry that may be expected.

BUFFALO FISH, ATCHAFALAYA (LA.) SUBSTATION.

[C. F. CULLER, in Charge.]

With the active cooperation of the Louisiana Conservation Commission in the form of financial aid in the operating costs of the station, in furnishing boats and other transportation facilities for the distribution of the output, and in other assistance the station in Louisiana was opened in December for the propagation of the buffalo fish. It was found necessary to move the hatchery building from its original location on the Atchafalaya River near the railroad station of the same name, because erosion of the river bank had advanced to within 10 feet of the foundation posts. A site was selected at Pelba, La., some 1½ miles west of Atchafalaya, and the building and its equipment relocated on the new site in time for the incubation of the season's egg collections.

Active fish-cultural operations began on March 1, when the first eggs were taken. The water temperature at this time was 54° F. and was immediately followed by a period of comparatively cold weather with a continuation of the low-water temperature. The incubation period on this lot of eggs was 21 days in a mean temperature of 54° F., about twice the time required for incubation in a water temperature of 60° F. Spawning continued until April 3, and during that time 142,850,000 eggs were obtained. Some 29,850,000 of them were planted on the spawning grounds; the remainder produced 51,000,000 fry for distribution.

It seemed probable that the new location of the hatchery would afford a more satisfactory water supply, and during the early part of the season this belief was justified. Later, with flood conditions on the Ouachita River, the Atchafalaya River received a large volume of turbid and discolored water, which, as in the past, caused a severe mortality among the green eggs under incubation. It seems evident that satisfactory water for the incubation of the eggs collected in this section is not to be obtained from the Atchafalaya River, and as clear water is available at no great depth by means of artesian wells it may be advisable to resort to this means for obtaining suitable water for hatchery purposes. It has been observed each season also that the turbid flood waters of the Ouachita River invariably cause a withdrawal of all the spawning fish from the affected areas.

MARINE FISHES.

Three well-equipped stations, one located in Maine and two in Massachusetts, whose work is confined to the propagation of the sea fishes, are operated by the bureau. During the fiscal year 1922 such work was addressed to eight species, the aggregate output of which amounted to 3,204,678,000 fertilized eggs and fry. There is a tendency toward the belief that much of the work of past years in marine fish culture has been of little value; that the causes making for abundance or scarcity of the marine fishes in any region are quite remote from any line of fish culture and beyond the control of man. If this theory is sound, the work of the fish-culturist as addressed to the marine fishes becomes, indeed, of no value. However, when the present trend of marine fish culture toward the conservation of the eggs in fish caught for market is taken into consideration and when it is realized that the market fishery is vigorously prosecuted over areas in which the fish have congregated for the express purpose, apparently, of spawning, and that truly enromous numbers of eggs are thus annually destroyed, it is difficult to believe that the salvage of these eggs by artificial methods can be entirely barren of results or that it does not justify the comparatively small outlay of funds thus expended.

BOOTHBAY HARBOR (ME.) STATION.

[E. E. HAHN, Superintendent.]

The principal activities of this station were concerned with the propagation of the winter flounder. Because of the prevailing scarcity of pollock in the Gloucester field the usual transfers of eggs of that species to the Boothbay Harbor hatchery were omitted, and the diligent search made during the season for eggs of the cod, haddock, and alewife was without results. There appeared to be no run of spawning haddock or cod, and but very few boats were engaged in fishing operations at the time when spawning fish might be expected. The roe contained in the few alewives secured was hard, and from the observations made it is evident that the spawning grounds of this fish are at a considerable distance from Boothbay Harbor.

Owing to the presence of ice on the fishing grounds, fishing operations for brood winter flounder as a source of egg supply for the station were begun later than usual and the season closed correspondingly late. Fyke nets were set on February 24, but no fish were taken until March 1, these being obtained by the station steamer and crew from nets set in small coves in Casco Bay. By March 5 all available nets had been installed, being set at points between Casco Bay and West Penobscot Bay, in Linekins Bay, and in and about Seal Harbor. The station steamer was used to fish the nets at the more distant points, making trips thereto at regular intervals until the close of the season on May 3. From all points some 7,000 spawners were secured, brought to the station, and transferred to retaining tables in the hatchery. The fish ran much smaller in size than in former years, but no loss was sustained during the period of their confinement, and there was an excellent yield of eggs of the finest

quality. From the 988,533,000 eggs obtained 922,777,000 fry were hatched and distributed, the deposits being made in the localities from which the brood fish were derived.

In accordance with past custom an exhibit of local fishes and other marine animals was maintained in the hatching room throughout the summer months, and it proved to be a source of much interest to the numerous visitors.

GLOUCESTER (MASS.) STATION.

[C. G. CORLISS, Superintendent.]

The work of the Gloucester (Mass.) station involved the pollock, the cod, the haddock, the winter flounder, and the pole flounder. The collection of pollock eggs, taken up on November 7 and continued until January 19, netted 507,270,000 eggs for incubation. Although there appeared to be a good body of fish on the inshore fishing grounds throughout the season, they were continually moving from place to place, necessitating frequent shifting of nets and resulting in smaller daily catches. This condition characterized the entire season's work and had a direct bearing on the decreased numbers of eggs obtained. The collection of cod eggs extended from December 7 to April 16, the largest collections, as usual, being obtained during March and April. Spawn takers from the station were engaged on boats fishing in Ipswich Bay and Massachusetts Bay, one spawn taker being sent to Plymouth, Mass., to investigate the reports of large numbers of eggs available from that point. The season's work again demonstrated the need of a serviceable boat for use in connection with the spring collection of cod and haddock eggs. Most seasons the fishing fleet is distributed over so wide an area that without a suitable boat it is not possible for the small number of spawn takers employed to cover more than a small portion of the field. The season's efforts netted 306,960,000 eggs, 124,060,000 of which were planted immediately after fertilization. The number incubated at the hatchery was further increased by the transfer of 30,070,000 eggs from the Woods Hole (Mass.) station.

The collections of haddock and winter flounder eggs were taken up in the usual manner and resulted in obtaining 542,110,000 haddock and 110,580,000 winter flounder eggs. Some 75,960,000 of the haddock eggs were deposited on the fishing grounds after fertilization. All of the eggs of the various species taken to the hatchery were incubated successfully and the fry deposited at suitable points from which the egg collections were obtained.

The work concerned with the pole flounder, undertaken for the first time near the close of the fiscal year 1921, was continued during the first 16 days of July, 1922, resulting in the collection of 5,090,000 eggs. An increase in the numbers of ripe fish taken in the fishery as the season advanced was expected, but no such increase was apparent up to the time the work closed. An examination of the ovaries of the fish taken on July 16 showed a wide variation in the development. Many of the fish had small undeveloped ovaries, and others, in smaller numbers, taken in the same place, contained ripe eggs. From the information obtained it seems evident that the spawning period is much protracted, but that the

main body of fish spawn in August and September in the vicinity of Gloucester, Mass. It appears also that the eggs of the pole flounder can not be successfully transported from the point of collection to the hatchery by the methods now in use in connection with the other species handled.

WOODS HOLE (MASS.) STATION.

[W. H. THOMAS, Superintendent.]

As a result of arrangements made with the fishermen in October, to furnish cod for a brood stock, consignments began arriving November 10, and shortly thereafter additional deliveries brought the total for the season up to 4,023. This was somewhat more than the work required, and it was really in excess of holding facilities, but the supply available varies from season to season, and as conditions in this respect can not be foreseen, it is necessary to accept the stock brought in to insure future cooperation in the work on the part of the fishermen. The first consignment of brood cod was transferred to the cistern in a sea-water temperature of 50° F. Experience has shown that the best results can not be expected from such transfers in a water temperature exceeding 45°, and in future an effort will be made to profit by such experience. In order to obviate the possibility of purchasing immature brood fish, all fishermen were especially requested not to take any cod for the station in the vicinity of the shore, and it was evident from their description of the places of capture that the fish were secured at points where spawning cod are known to congregate. As in past years, the females outnumbered the males, but this could not be remedied, owing to the necessity of accepting all deliveries. The average weight of the brood fish was 6½ pounds, somewhat in excess of the usual average. Despite the fact that the quality of the stock as a whole was first class and the egg collections large, the percentage of hatch was disappointing. This is accounted for by the partial failure of the automatic temperature control to operate, the temperature at times fluctuating between 35 and 40° F. instead of remaining constant at 38. Salt appeared to collect on the valve and check its operation.

Trouble was encountered also from an accumulation of air in the cod boxes. This was particularly noticeable just after the filter was cleaned, there being so much of it at times that circulation was stopped, killing the spawn. Under the new arrangement effected last year the water supply for the hatchery is now pumped from the harbor into two wood stave tanks of 8,000 and 10,000 gallons capacity. Until the temperature drops to 38° F. it flows by gravity from these tanks to the hatchery through 6-inch pipe, thence through connecting 4-inch pipes to 2-inch lines extended over each set of tables, and from there through ⅜-inch pet cocks and connecting rubber tubes to the hatching boxes on the tables, the overflow from the boxes passing into a drain and back into the harbor. After the temperature has reached 38° the water is passed through pipes to a heating tank in the boiler room and the direct supply to the hatchery practically stopped. The overflow from the hatching boxes is then run into the cod cistern. The overflow from the

cistern is conducted into the filter, thence to a reservoir, and from there is pumped back into the storage tanks. By this means the water is heated in passing from the tanks to the hatchery, and while in the reservoir it can be again heated, if necessary, by a coil of pipe through which is passed water from the exhaust steam used in heating the building. This arrangement effects a considerable saving in coal as compared with past years.

During the winter, collections of winter-flounder spawn were made as usual at Waquoit, Mass., and Wickford, R. I., and although the operations were not as productive as in some previous years the results were on the whole fairly satisfactory, this being made possible largely through the strenuous efforts of the employees engaged in the work. In the Waquoit field particularly the spawn takers are beset with many difficulties. Not infrequently ice 8 inches or more in thickness must be sawed through before the nets used in the capture of the brood fish can be set or examined. Even under milder weather conditions there are many hardships to undergo, making the work exceedingly difficult. Operations at Waquoit extended from January 12 to March 24, during which time 819,927,000 eggs were secured, or nearly 35,000,000 more than in the previous fiscal year. An employee detailed to the Wickford field throughout the month of March obtained 228,768,000 eggs. The weather conditions during this period were comparatively mild, but for some reason the catch of fish was light. In the Newport field the fish are taken in deep water, which is so cold that they do not spawn freely until it is too late in the season to make successful shipments of eggs to the Woods Hole hatchery. Owing to this fact only 123,783,000 eggs were taken, notwithstanding the considerable numbers of brood fish secured. Possibly the fish can be held in live cars at some point where the water is shallower and warmer, and it is intended to make some investigations along this line at the first opportunity. Egg collections of this species from all sources amounted to 1,212,916,000, of which 166,751,000 were planted in the eyed stage of development. The remainder were hatched, yielding 844,381,000 fry, the percentage of hatch being 82.7.

In an effort to secure eggs of the mackerel almost daily visits were made to the local traps throughout the month of June, and as a result 2,022,000 were collected. The eggs were of uniformly good quality, nearly 99 per cent producing fry. Eggs of the scup to the number of 3,425,000 were also taken. In the early history of the station a few eggs of this species were occassionally secured, but until this year none whatever have been obtained since 1911, when a collection of 634,000 was made. The present season's collection was four times larger than any ever previously made. The percentage of hatch was 73.1, and had it not been for one large lot that was practically a total loss a very large percentage of hatch would have resulted. The efforts put forth to secure eggs of the sea bass were not wholly fruitless, as 32,000 were taken and hatched and the fry distributed without apparent loss. The last previous collection of these eggs was in 1910, when 850,000 were taken.

To satisfy a demand for steelhead for stocking a fresh-water pond at Mashpee, Mass., 25,000 eggs of that species were received at the station during the spring from Birdsview, Wash. Although the

consignment contained only about 400 white eggs on arrival, a large number had a cloudy appearance, and these either died in the egg stage or the resulting fry succumbed soon after hatching. The fry were planted immediately after the absorption of the yolk sac, the output amounting to 20,000.

NOTE CONCERNING LOBSTER PROPAGATION.

In various parts of the New England States there appears to be a growing sentiment in favor of the resumption of lobster propagation. This valuable crustacean formerly came extensively under artificial propagation at the marine stations, and for a number of years it formed the most important part of the work of the Boothbay Harbor (Me.) station. The hatchery at this point is particularly well located and equipped for the purpose, and with the lobster pound at Pemaquid as an auxiliary the station is prepared to save, with their eggs, many thousands of the egg-bearing lobsters which, there is every reason to believe, are now annually finding their way to the market.

The abandonment of the work resulted from a combination of circumstances, the most important, perhaps, being the failure of the interests most directly concerned to cooperate with the bureau. During the fiscal year 1921 the bureau was petitioned by a considerable number of citizens to again take up lobster propagation at the Woods Hole (Mass.) station, and during the current year the same topic has been the subject of much correspondence with persons interested in the lobster fisheries of Maine. There appears to be a quite general feeling that the present State regulations are not successful in preventing large numbers of the egg-bearing lobsters from reaching the market.

ANADROMOUS FISHES OF ATLANTIC RIVERS.

The fish-cultural work concerned with the anadromous fishes of Atlantic coastal streams during the fiscal year 1922 shows very satisfactory results. Under this group are included the Atlantic salmon, the humpbacked salmon introduced on the Atlantic coast, the shad, the river herrings (*Pomolobus æstivalis* and *P. pseudoharengus*), and the striped bass, or rockfish. The increased output of shad and river herrings is particularly noteworthy.

SHAD, BRYANS POINT (MD.) SUBSTATION.

[L. G. HARRON, Superintendent.]

This station was opened at the beginning of the yellow-perch spawning season on March 1 and was closed May 20, shortly after the shad had finished spawning. The activities in connection with the yellow-perch work are discussed in connection with the propagation of the fishes of the Great Lakes, on page 46. The weather throughout the early spring was uniformly cold and stormy, the mean water temperature for the first 25 days of March being as low as 44° F. Such a condition always favors a good run of shad to the spawning areas in the Potomac River, as it causes the main body of the run of fish to ascend the warmer waters of the main river chan-

nel, thus escaping the numerous pound nets set for their interception on the flats and shallows of Chesapeake Bay. On April 6 shad in plentiful numbers were observed on the natural spawning grounds in the vicinity of the station, their arrival being at least 20 days later than in the preceding year, when abnormally high water temperatures ruled throughout the month of March. On April 10, when the first shad in spawning condition was found, and for 12 days thereafter, the water temperature remained too low for the successful ripening of their eggs. Consequently, the egg collections during this period, amounting to 5,442,000, were small as compared with the same period in former years. However, on April 24 a decided improvement in water temperatures was noted, and during the remaining days of the month eggs arrived at the hatchery in large numbers, giving a total up to and including April 30 of 31,306,000, which is seldom exceeded for that month.

These few days in late April proved to be the height of the egg-collecting season, as the catch of fish began falling off rapidly soon after the beginning of May, and by the 12th of that month many of the fishermen had suspended their operations. Eggs ceased coming in very shortly thereafter, the last consignment being received May 15. Of the season's total, aggregating 47,478,000, one lot of 1,311,000 was sent to the bureau's central station at Washington, D. C., for aquarial display; the remainder were hatched, producing a normal percentage of healthy vigorous fry for return to the local spawning grounds of the Potomac and its adjacent tributaries.

The season also proved a very successful one for the shad fishermen. They made unusually heavy captures throughout practically the whole of April, and though the prices obtained for their product were not as high as had prevailed during the preceding five years, their financial returns were greater.

SHAD AND RIVER HERRINGS, EDENTON (N. C.) STATION.

[DELL BROWN, Superintendent.]

There is also to be recorded a satisfactory increase in the output of shad in North Carolina waters. The spawning season at Edenton extended from March 28 to May 8, during which time 35,201,000 ripe eggs were obtained for incubation. More than 78 per cent of these produced fry at a cost of about $69 per million.

Because of the poor quality of the eggs obtained from fish taken in pound nets in this section, all shad eggs during the past season were taken from fish caught in gill nets, the fishermen operating on areas from which such apparatus is normally excluded by law. During the shad-spawning season licenses countersigned by the bureau's agent were issued by the State authorities to certain fishermen permitting them to use gill nets on the restricted areas, provided that all ripe eggs thus obtained were delivered to the Edenton hatchery. It is apparent that the prevailing sentiment of the region is opposed to this method of securing shad eggs, and many of the local citizens are of the opinion that greater results would accrue were the gill-net fishermen excluded entirely from the restricted area and the shad allowed to spawn naturally, basing their argument on the ground that only a small percentage of the fish taken by the gill nets contain ripe eggs.

Coincident with the spawning season of the shad in Albemarle Sound is that of the river herrings, two species, the branch herring (*Pomolobus pseudoharengus*) and the glut herring (*P. æstivalis*), coming under artificial propagation at the Edenton hatchery. Although less abundant, the branch herring, because of its larger size and early run, is more highly prized than the glut herring, though large numbers of the latter species are absorbed by the local markets.

From observations made of the spawning habits of these fish at Edenton during the past three seasons it appears that the branch herring spawn in about the same temperature as the shad, 62° F., but that the spawning of the glut herring is delayed until the water reaches a temperature of 66° F. The eggs of both species when first taken have a strong adhesive tendency. To overcome this in artificial propagation, they are passed through a fine screen immediately after being delivered at the hatchery. The incubation of branch-herring eggs is about five days, with a mean water temperature of 62° F., while the incubation of glut-herring eggs is completed in 36 hours at the higher water temperature of 66° F. The aggregate egg collections of the two species for the fiscal year was 116,920,000. From this number of eggs 82,600,000 fry were produced, all of which were planted on the local spawning grounds. As compared with last year's output of river herring, 43,815,000, the figures for the present year seem large, but they do not represent the full possibilities in artificial propagation that are present in Albemarle Sound. Closer cooperation on the part of the market fishermen and funds for the maintenance of operations over a longer period of time would undoubtedly very materially increase the amount of valuable work that could be accomplished. Like most of the bureau's fish-cultural work in connection with the commercial species, the herring eggs were all obtained from fish taken in pound nets by the local market fishermen.

The Edenton (N. C.) station, in addition to the work discussed above, produces annually a variety of the so-called pond fishes. This branch of the work is mentioned on page 77.

STRIPED BASS, WELDON (N. C.) SUBSTATION.

[Dell Brown, Superintendent.]

An increase of fully 100 per cent is to be recorded in the amount of work accomplished with the striped bass at this station during the fiscal year 1922 as compared with the previous year. This may be attributed to the increased interest in the work on the part of the commercial fishermen, and if it is possible to maintain this spirit of cooperation among them it will enable the bureau to further extend its valuable line of work. The spawning season opened on April 12, somewhat earlier than usual, and egg collections were continued until May 15. This year's record output is in line with the increase in the output that has occurred almost without interruption since the inception of striped-bass propagation on the Roanoke River.

ATLANTIC AND HUMPBACKED SALMONS, CRAIG BROOK (ME.) STATION.

[J. D. De Rocher, Superintendent.]

During June of the fiscal year 1921 adult Atlantic salmon to the number of 208 were purchased from local fishermen operating weirs

in the Penobscot River and held in the Dead Brook inclosure pending the development of their eggs, in accordance with the usual custom. At spawning time, in late October, the 190 fish of this lot remaining yielded 572,000 eggs. This stock of eggs was increased through another exchange with the Canadian Government, whereby the station received 1,000,000 Atlantic-salmon eggs in return for an equal number of eggs of the landlocked salmon, rainbow trout, and black-spotted trout, these being supplied from other stations of the bureau. Both lots of Atlantic-salmon eggs were incubated with excellent results. The resulting fry to the number of 1,334,000 were deposited in Maine rivers, principally the Penobscot, and approximately 100,000 fingerlings remained on hand at the end of the fiscal year.

During June, 1922, the attempts made to purchase adult salmon for a source of egg supply for the coming year met with rather indifferent results. The bureau's recently adopted policy of refusing longer to pay a so-called bonus of 60 cents per fish for careful handling in addition to the market price, together with its decision to reduce the average weight of the fish acquired, influenced most of the fishermen to sell their catch in the open market rather than to the bureau. Only three fishermen cooperated in obtaining the 51 brood fish secured.

The attitude of these fishermen is difficult to understand. Most of them express themselves as being in accord with the work, and they readily concede that, because of the unnatural conditions now existing in the Penobscot, the run of salmon in the river is apparently dependent on the output of the hatchery. They also recognize that the salmon fishery has afforded them remunerative employment each season for many years. At the same time they are unwilling to accept this form of business insurance without receiving extra compensation for the small amount of trouble involved in holding the fish for the bureau's agents, although it entails no monetary loss from the sale of their fish and insures the salvage of a large percentage of the prospective progeny and the ultimate release of the adult fish, for which they will receive the full market value.

The spring run of salmon in the Penobscot appeared to be light, but reports were received, apparently from reliable sources, of the presence of large numbers in the Penobscot and Dennys Rivers during August. It was stated by observers that the run of fish in both these streams was larger than for a long period of years. The run in the Dennys River is particularly noteworthy, since for many years this once important salmon stream has been quite barren of the species. Largely through the efforts of the bureau a fishway has been installed in the dam at Dennysville and, beginning in 1917, the river has been stocked annually with salmon fingerlings hatched from eggs taken in the Penobscot River. Present conditions with reference to Atlantic-salmon propagation are not entirely satisfactory, and the meagerness of accurate information concerning many details of the matter suggests the desirability of a rather thorough canvass of the situation.

Fish-cultural operations in connection with the humpbacked salmon in Maine waters were undertaken in the fall of 1921 for the second time. During September and October employees of the Craig Brook station obtained from the Dennys River, at Dennysville, Me.,

445,000 eggs of this species, and later on approximately 369,000 fry resulting therefrom were returned to the river. It is probable that a considerably greater number of eggs might have been secured had the conditions in the Pembroke River been more favorable. During the entire spawning season the water stages in this stream were too low to permit of the ascent of fish. The continuance of this run of humpbacked salmon, transplanted from the Pacific coast in Maine rivers, is an interesting fact. It occurs only in alternate years, and an effort to establish an annual run would perhaps be a wise undertaking.

RESCUE OF STRANDED FOOD FISHES.

[C. F. CULLER, in Charge.]

During the fiscal year 1922 the total results of the bureau's rescue operations amounted to 179,475,069 fish, all of them being of direct importance to the regions in which the work was done. In the prosecution of such work 13 crews operated on the upper Mississippi River, in territory contiguous to the Homer (Minn.) station, La Crosse, Wis., and Bellevue and Marquette, Iowa. One crew was engaged on the Illinois River in the vicinity of Meredosia, Ill., and a considerable amount of rescue work on the Mississippi River was directed from the Fairport Biological Laboratory, in connection with the propagation of the fresh-water mussel. The operations also included a comparatively small amount of rescue work in fields around the San Marcos (Tex.) station. The tabular statement on page 10, showing the results of the bureau's activities along this line, indicates clearly the species and the number of fish salvaged at each point and their final disposition. The work was done at an average cost of approximately 14 cents per thousand fish rescued.

Rescue work for the season was first undertaken on July 5, in the vicinity of Homer, Minn., and was prosecuted as actively as possible at all the points mentioned until the exhaustion of the available funds on October 29 compelled its early closing, notwithstanding the fact that a number of landlocked pools in the vicinity of Marquette, Iowa, remained untouched. The work was rendered unusually difficult in some respects because of the unusually low stage of the river and the hot, dry summer. Because of excessively high temperatures at certain points large numbers of fish were found dead in pools of an average depth of 10 inches. Even such species as carp and catfish, which are particularly resistant to these conditions, suffered heavy mortality. The high air and water temperatures also made difficult the transfer of rescued fish to the river or the holding stations, and the utmost care was required to accomplish such tranfers successfully. In one respect the low water stages were of direct advantage to the work. As the overflow was restricted to a considerable extent by the river not reaching its usual high mark during the spring rise, the ponds left by the receding waters were all more conveniently located with reference to the river than is the case in seasons of a wider overflow. On the Mississippi one crew with houseboat operated from Prescott, Wis., to the head of Lake Pepin, thence to Brownsville, Minn., and Genoa, Wis.; one crew with houseboat covered the territory from Wabasha, to Fountain City, and

thence to Dakota, all in Minnesota; two crews worked from Homer, Minn.; one each from La Crosse, Genoa, and Ferryville, Wis.; one from Marquette, Iowa; one with houseboat between Dubuque and Bellevue, Iowa; and one from Bellevue, Iowa.

The work at Meredosia, Ill., was discontinued on September 15, at which time steps were taken to abandon the station permanently. Such part of the property as could be used to advantage at other points was transferred, while the buildings and the equipment that could not be moved successfully or that had no value in connection with the work elsewhere were sold to the highest bidder by authority of the Secretary of Commerce. The work that could be accomplished profitably at this point was decreasing in amount from year to year, as the movements of the fishing crews were becoming more and more restricted by the establishment of duck-shooting preserves. Large portions of this territory were also being reclaimed for agriculture.

FISHES OF MINOR INTERIOR WATERS.

In that part of its work relating to production and distribution of fish for stocking interior waters of the country the bureau solicits the participation of the public. It cooperates with interested individuals or associations in deciding as to the waters to be stocked and considers their suggestions as to the species of fish best suited therefor. It relies upon applicants to see that the fish furnished are properly planted in the waters for which they are assigned, and that they are afforded proper protection against illegal or unsportsmanlike methods of fishing. Although the species of fish involved are generally classed as game fish, they have important value, also, as food.

The benefits accruing from this phase of fish-cultural work are considered invaluable. Not only is there an economic gain in the increase of the food supply by the utilization of otherwise unproductive waters, but there is an educational effect that develops and fosters a sentiment favorable to the protection and growth of fish life. Moreover, innumerable persons derive direct and important benefits from a day's fishing in the open places.

While this part of the bureau's work has increased in volume with the development of its fish-cultural activities, it has not increased in the same proportion as has the work that is concerned with the commercial species, and whereas a few years ago the output of fishes for the interior waters represented from 8 to 10 per cent of the aggregate output, it now represents less than 1 per cent of such aggregate. The urgent need for an immediate expansion of this work is reiterated.

The numbers of fish and fish eggs produced and distributed for the replenishment of interior waters during the fiscal year 1922, including those diverted for this purpose from the rescue operations along the Mississippi River, were as follows:

Catfish	152, 525
Landlocked salmon	398, 010
Rainbow trout	7, 228, 225
Black-spotted trout	2, 521, 500
Loch Leven trout	56, 000
Brook trout	9, 991, 855

Grayling	250,000
Crappie	42,352
Large-mouthed black bass	1,946,432
Small-mouthed black bass	645,808
Rock bass	46,258
Warmouth bass	2,515
Sunfish	141,172
Total	23,422,652

ROCKY MOUNTAIN TROUT STATIONS.

This group comprises the stations with their auxiliaries in the States of Montana, Colorado, Wyoming, South Dakota, and Utah. Their work is addressed to the trout indigenous to the region, to the brook trout and rainbow trout, which have been transplanted from other sections of the country, and to small numbers of the Loch Leven trout. The aggregate output of this group for the fiscal year 1922 was as follows:

Brook trout	4,818,435
Rainbow trout	3,324,840
Black-spotted trout	2,498,500
Loch Leven trout	36,000
Total	10,677,775

BOZEMAN (MONT.) STATION AND SUBSTATIONS.

[W. T. THOMPSON, Superintendent.]

Besides the main station at Bozeman there were two important auxiliaries, one on Meadow Creek in the Madison Valley, Mont., and the other in the Glacier National Park, operated in connection with the work of this field during the fiscal year 1922.

BOZEMAN (MONT.) STATION.

Fish-cultural work consisted in the propagation of brook, rainbow, and black-spotted trouts from eggs procured from brood stock maintained at the station, by transfer from field and other stations of the bureau, from the Montana Fish and Game Commission, and by purchase from commercial dealers. The percentage of hatch ranged from 70 to 99 per cent among the different lots, the latter percentage occurring among the black-spotted trout transferred from Yellowstone Park. During the summer and fall of 1921 about 1,500,000 fingerlings of all species were delivered to the bureau's cars for distribution to applicants throughout the States usually served by this station, and from the past season's hatch there was a similar number on hand for distribution during the summer and fall of 1922.

Of the brook-trout eggs handled at the station, 1,000,000, in round numbers, were supplied from the Springville (Utah) and Leadville (Colo.) stations of the bureau, 500,000 were purchased from a commercial dealer, and some 60,000 were taken from the station brood stock. The rainbow trout were all from eggs collected at the substation on Meadow Creek, while the black-spotted trout were from the Yellowstone National Park and from the Montana Fish and Game Commission. The number of eggs and fry received from the

latter source numbered upward of 1,500,000. To accommodate this extra assignment of valuable stock, it was necessary to provide additional hatchery space. This was accomplished by building an annex on the southeast side of the hatchery building, 50 by 20 feet in dimensions, equipped with 20 standard hatching troughs. In this connection appreciation is again expressed of the practical and liberal assistance rendered by the State of Montana in developing fish-cultural projects in which the bureau is particularly interested.

Of interest in connection with the distribution of fish from the Bozeman station during the year was the planting of brook trout in Kootenai River and Cameron Lakes, on the international boundary. The trip was not accomplished without difficulties, but none of them proved serious, and some 30,000 brook trout of the fingerling No. 1½ size, though four days en route, were successfully deposited in these waters. In making this trip the bureau received valuable assistance from the National Park Service and the Canadian Department of Marine and Fisheries, as well as from the Great Northern and the Northern Pacific Railroad Cos., who in each case furnished free transportation over its line. An opportunity was afforded the superintendent on his return from this trip to visit some of the lakes in the region with a view of ascertaining the possibilities for extending the fish-cultural work, and some interesting prospects were noted.

The State of Montana is devoting some effort toward developing a commercial fishery for the whitefish and lake trout in Flathead Lake. Working along this line the State collected whitefish eggs from St. Marys Lake, which were incubated at the Somers (Mont.) hatchery, and after making generous provision for parent waters the remaining fry were planted in Flathead Lake, together with additional fry from eggs furnished by the bureau from the Great Lakes.

MEADOW CREEK (MONT.) SUBSTATION.

Opportunity was afforded during the year to enlarge and improve the buildings at this important substation. The hatchery building, originally 18 by 24 feet, was enlarged to 24 by 38 feet, the additional space was equipped with troughs, and one room and porches were added to the cottage. Some 2,300 feet of wood stave pipe was also purchased and laid to connect the hatchery with Wilson Spring. The station and its equipment are now in good condition, and the advantages of the new water supply were evident in the improved condition of the eggs and fry handled.

The season's take of rainbow-trout eggs in Meadow Creek was below the average, due possibly to cold and otherwise unfavorable weather. Spawn taking commenced on April 24, about 10 days later than in a normal season, and ended June 8, fully a week earlier than usual. During this short period 1,800,000 eggs were secured. The usual shipments were made to the Montana Commission, to the bureau's stations and substations at Bozeman, Mont., Glacier National Park, and other points, and a reasonable number were reserved for incubation, with the view of replenishing local waters. Black-spotted trout obtained from the State of Montana and from the bureau's substation in the Yellowstone Park were also handled, the two lots yielding 425,000 fry of that species for distribution.

GLACIER NATIONAL PARK (MONT.) SUBSTATION.

The work of this small hatchery was addressed to the incubation of rainbow-trout eggs received from the Meadow Creek collections, black-spotted-trout eggs from the Yellowstone National Park and the State of Montana, and steelhead eggs from Applegate Creek, Oreg. The records indicate a distribution of 168,000 black-spotted trout, 250,000 rainbow trout, and 48,000 brook trout, with approximately 160,000 fingerling fish on hand at the end of the year. The bureau is indebted to the State of Montana for the brook-trout fingerlings appearing in the above record, and to this number may rightfully be added the 30,000 fingerlings of this species mentioned as having been placed in Kootenai River and Cameron Lakes.

In recent years the pelican has been much discussed in connection with the problem of fish culture and conservation in certain sections of the territory in this region, particularly as regards the Yellowstone National Park and the Madison Valley, in Montana. This bird, protected by law, it is claimed by many who are apparently in a position to know, constitutes one of the most important agencies in the destruction of the game fishes, and the evidence produced in support of this statement is of a convincing nature.

In order to obtain more authoritative knowledge on this important subject an investigator, working under the direction of the division of scientific inquiry, was employed near the close of the fiscal year to investigate the habits of the pelican in Yellowstone National Park.

LEADVILLE (COLO.) STATION AND SUBSTATION.

[C. B. GRATER, Superintendent.]

LEADVILLE (COLO.) STATION.

During the year the rearing capacity of the Leadville station was increased by repairing and connecting with the water supply the 16 cement ponds in front of the hatchery building. Additional troughs were also placed in the hatchery.

The brook trout is the important species propagated at this station, and excellent results attended the efforts along this line during the fiscal year 1922. The eggs handled are obtained almost exclusively from privately owned lakes, where, under agreement with the owners, the bureau's fish-culturists annually make egg collections from spawning trout. The eggs thus obtained are all taken to the Leadville hatchery, where a predetermined percentage of the total collections from each point of eyed eggs, fry, or fingerling fish are held subject to the owner's disposal. During the fiscal year 1922 collections were made from seven Colorado lakes, as follows:

Turquoise	3, 027, 200
Engelbrecht	2, 108, 700
Carroll	235, 500
Northfield	49, 900
Fred Neal	176, 000
Musgrove	587, 600
Evergreen	96, 500
Total	6, 281, 400

It is interesting to note that the collection obtained from Turquoise Lake was the largest ever made at that point. In addition to the brook-trout eggs obtained from this lake 37,000 eggs of the Loch Leven trout were secured. Transfers from other stations of the bureau to the Leadville hatchery included upward of 80,000 rainbow-trout eggs from Saratoga, Wyo., 200,000 black-spotted-trout eggs from the Yellowstone Park, and 50,000 lake-trout eggs from the Duluth station. The rainbow trout were used largely for stocking a lake in Jefferson County, Colo., where there are excellent prospects of developing a profitable field station, and 25,000 of the lake trout were delivered to an applicant in Pitkin County, Colo. The remainder of the fish entered into the general distribution in Colorado and New Mexico, or were included in the stock—some 2,500,000—remaining on hand at the close of the year.

YELLOWSTONE NATIONAL PARK (WYO.) SUBSTATION.

This station was operated during the year under the direction of the superintendent of the Leadville (Colo.) hatchery. The fish-cultural work, which involves a portion of two fiscal years, opened at Fish Lake, near Soda Butte, on June 8, and the collections of black-spotted-trout eggs at this point to the close of the year amounted to 263,500. Late in the season of the previous fiscal year and during the season of 1922 a building of log construction was put up for the bureau by employees of the National Park Service. As this building was not available for use during the spawning period, the eggs taken at Fish Lake were transferred to the Lake hatchery for incubation.

The spawning season of the black-spotted trout on Yellowstone Lake began on June 9, and the results of the season's efforts, both as to egg collections and the number of young fish returned to park waters, were the most satisfactory in a long period of years. The usual egg-collecting area was considerably augmented by extending it to streams not previously occupied along the South Arm of Yellowstone Lake, and, largely through the cooperation of officers of the park service, the unusually large output of fry and fingerling fish was disseminated over a much wider territory than ever before. Through the courtesy of the Montana Fish and Game Commission and by judicious exchanges of eggs, brook trout, rainbow trout, and grayling, as well as the native black-spotted trout, were available for distribution in suitable waters of the park.

SARATOGA (WYO.) STATION.

[O. N. BALDWIN, Superintendent.]

A special appropriation provided by Congress and available July 1, 1922, permitted the erection of two cottages at the main station for the convenience and comfort of the statutory employees. These are of frame construction, with four rooms, bath, and cellar each. Funds were also available from the same appropriation for some development work at the field stations. It was therefore possible to erect a log building 28 by 36 feet equipped with 20 standard hatching troughs, and a cabin, also of logs, 20 by 26 feet, for the accommodation of the employees in charge. These buildings are

located on a tract of land near the confluence of the North Platte River and Lost Creek, in Carbon County, Wyo., adjacent to the Pathfinder Reservoir project of the United States Reclamation Service. In furnishing water for the hatchery a concrete dam across Lost Creek was necessary.

The distribution from the Saratoga station consisted of 298,500 brook trout, 924,740 rainbow trout, and 9,000 Loch Leven trout, with upward of 1,000,000 fish on hand at the close of the year.

Egg collections at the main station were confined to 130,000 brook-trout eggs and a small number of Loch Leven trout eggs from the brood stock. The rainbow trout at the field stations gave promise of being unusually successful. Racks for the capture of spawning fish were in place in Sage Creek, Canon Creek, and Lost Creek well in advance of the spawning season, and good numbers of fish were present in each stream. On May 10 a blizzard of intense violence, continuing for five days, visited this section, making all movement abroad impossible. The storm was followed immediately by mild weather, and the floods resulting from the rapid melting of the quantities of snow rendered fishing impracticable for a further period. With the abatement of the storm and flood the larger part of the fish had passed upstream. Eggs to the number of 1,355,800 were obtained, however. Reserving a liberal number to be incubated at the Lost Creek hatchery for the replenishment of the local streams, the remaining number were divided between the State of Wyoming and the bureau, the bureau's eggs being forwarded to the Saratoga station.

SPEARFISH (S. DAK.) STATION.

[D. C. BOOTH, Superintendent.]

Efforts at this station are confined to the propagation of the brook, rainbow, and Loch Leven trouts. Nearly 600,000 eggs of all species were produced from the station brood stock, and about 350,000 brook and rainbow trout eggs were transferred from other stations of the bureau. The percentage of hatch ranged from 52 to 74, and all but about 10,000 of the young fish were distributed throughout the territory ordinarily served.

Impelled by the difficulties annually experienced in obtaining satisfactory supplies of brook-trout eggs from outside sources, the station has recently been engaged in the production of a brood stock of this species. As a result there were on hand at the beginning of the fiscal year brood fish of excellent quality in adequate numbers to furnish sufficient eggs for the season's work. Before spawning time arrived, however, a large number of them had disappeared, and there is reason to believe they were stolen, though a night watch had been maintained during most of the year. As a consequence of the greatly reduced egg collections, a small number of eggs were taken from the few wild trout obtainable in neighboring streams, and 305,000 were shipped from the Springville (Utah) station. The total supply from these three sources aggregated 738,400, from which 301,500 fingerling fish were distributed, and a smaller number remained on hand at the close of the year.

From 66,150 Loch Leven trout eggs taken from station brood stock 27,000 fingerling fish were produced and distributed. This species, which is highly regarded by local fishermen on account of its game qualities, appears to outnumber any other trout in the Black Hills region, though the bureau's distributions of it have been small as compared with those of the brook and black-spotted trouts. This is probably attributable to the more vigorous nature of the Loch Leven and its ability to withstand conditions that tend to result disastrously to other species. During May and June the station distributed approximately 59,000 rainbow-trout fingerlings, derived from eggs secured from domesticated stock at the station, and early in June a shipment of about 53,000 eggs of this species was received from the Saratoga station. The eggs were in first-class condition on arrival, and the subsequent losses of eggs and fry were merely nominal. Owing to their excellent quality it is the intention to reserve a few thousand of these young fish to be reared for a brood stock.

SPRINGVILLE (UTAH) STATION.

[CLAUDIUS WALLICH, Superintendent.]

Fish-cultural work at this station proceeded along the usual lines, and the aggregate output of the various species handled during the year shows a satisfactory increase over that of the previous year. Brook-trout eggs were obtained from the collecting station on Twin Creeks, a tributary of Fish Lake, which field for a number of years past has been operated jointly by the bureau and the State of Utah. Eggs to the number of 7,250,000 were obtained during the spawning season, extending from October 23 to the end of November, and the collections were divided equally between the interested parties. There has been a steady and very gratifying increase in the numbers of spawning brook trout in evidence in all the spawning areas of Fish Lake, together with a corresponding increase in the egg collections each season. During the season of 1922 the largest number of eggs ever taken from the lakes were all obtained from spawning areas in Twin Creeks, and no attempt was made to work the numerous spawning beds on the west and south sides of the lake, where spawning fish were unusually numerous. This improved run of fish is attributed to systematic plantings of 3 and 4 inch fingerlings in the lake every year since fish culture was first undertaken in this region. The experience gained through a number of years having clearly indicated that no satisfactory results could be expected through the maintenance of a brood stock of brook trout, all of the brood fish of that species on hand at the Springville station were liberated during the year in open waters of the State. The results already accomplished at the field station devoted to this species show that efforts in brook-trout propagation can be more profitably applied in this direction.

About 482,000 eggs were obtained from the brood stock of rainbow trout. This species produces much more satisfactory results under domestication at the Springville station than does the brook trout. As funds were not available for maintaining a field force for collecting rainbow-trout eggs, an agreement was effected with the State Commissioner of Fish and Game for delivery to the bureau

of a limited number of eggs at the nominal cost of 3 cents per thousand f. o. b. the State hatchery at either Richfield or Sigurd, Utah. As an outcome of this arrangement 1,647,000 green eggs were secured. The policy of stocking the Kyune Reservoir liberally each year with rainbow trout and brook trout was continued, and prospects are encouraging for early results in the way of egg collections from this body of water.

The results from the brood stock of native black-spotted trout were disappointing in the extreme, only 23,000 eggs being taken from the 240 three-year old female fish in the station ponds, and these proved of inferior quality. No satisfactory explanation of this failure is at hand, except that it seems to coincide with the results of past efforts to domesticate this species of trout at other stations of the bureau. All of the brood fish appeared to be constantly healthy. They have made a satisfactory growth, and no excessive mortality has been observed. Nevertheless, but few of the fish showed signs of fecundity at the spawning season. This station is now holding in ponds in an experimental way a small number of the common catfish obtained from the Mississippi River.

The rearing capacity of the station was increased during the year by the construction of four ponds, each 4 by 50 feet in dimensions, with natural earth sides and bottoms, supplied with water from the hatchery overflow. A further improvement to the pond system was effected by diverting surplus water from the Strawberry irrigation canal. This water is always turbid, and it has been a source of great annoyance, not only at the bureau's station, but at the State hatchery and to local agriculturists. By the cooperation of all interested parties a considerable amount of work has been accomplished toward the construction of ditches and flumes to divert this waste water to the dam, and a marked improvement has resulted.

NEW ENGLAND TROUT AND SALMON STATIONS.

This group includes the five stations and their substations located in the States of Maine, New Hampshire, Vermont, and Massachusetts, whose work is concerned principally with the brook and rainbow trouts and the landlocked salmon, though small numbers of such species as yellow perch, pike perch, smelt, and small-mouthed black bass also appear in their outputs.

BERKSHIRE (MASS.) STATION.

[W. A. CASLER, Superintendent.]

This station, situated in Berkshire County, Mass., near the village of Hartsville, was acquired under a deed of gift. At the time the property was taken over all buildings, walks, and ponds were in need of immediate repairs. Such repair work has been accomplished as rapidly as possible by devoting each year a portion of the very limited funds available for the operation of the station thereto. At the present time the buildings are all much improved, and the grounds have been maintained with reasonable care. The condition of the dams in many of the ponds is such that practical repairs can be accomplished only by a greater expenditure than is possible under the amount available for the maintenance of the station, and the

bureau has not felt warranted in asking Congress for special funds for this purpose in recent years.

The species of fish propagated at this station during the year included brook trout, rainbow trout, yellow perch, and pike perch. Brook-trout egg collections from the brood stock amounted to 260,000. The losses on these eggs during the incubation period, and again just prior to the absorption of the food sac, were so heavy that only 185,000 fry were produced and only 105,000 reached the fingerling stage and were distributed. The mortality is believed to have been largely due to the advanced age of the brood fish, which had been on hand for seven or eight years. With the view of remedying this defect, 500 fingerlings are now being reared at the station, and they will eventually replace the old brood stock. In addition to the brook-trout eggs collected, 88,900 eyed eggs were purchased from a commercial hatchery in Massachusetts, and from them a 98 percentage of fry was realized. All of these fish were distributed in waters in Massachusetts, Connecticut, and New York.

Fifty thousand eyed rainbow-trout eggs, transferred from the bureau's station at White Sulphur Springs, W. Va., were incubated with a 7 per cent loss, and 5,000 of this species collected from the station brood stock yielded a hatch of 43 per cent. As was the case with the brook trout, the advanced age of the parent fish was no doubt largely responsible for the inferior results, and on permission from the Washington office the brood rainbows were planted in Massachusetts waters.

Two hundred thousand yellow-perch eggs, transferred in an ordinary 10-gallon shipping can from the Swanton (Vt.) station, were incubated, and the fry were delivered to applicants in good condition. A further consignment of 3,300,000 eyed pike-perch eggs was transferred from the Swanton hatchery, and, though the station is not equipped for handling such eggs, 90 per cent of them produced fry, all of which were furnished to applicants.

CRAIG BROOK (ME.) STATION.

[J. D. De Rocher, Superintendent.]

That part of the fish-cultural work of this station addressed to the Atlantic salmon is discussed in connection with anadromous fishes of the Atlantic rivers on page 55.

During December, 1921, two consignments of eyed brook-trout eggs were received from commercial hatcheries, one in Maine and one in Massachusetts, and a third consignment was forwarded from Grand Lake Stream, Me., this comprising part of a shipment of eggs previously made to that point by the Pennsylvania Department of Fisheries. The eggs derived from the Massachusetts establishment produced a hatch of over 96 per cent and those from the Maine commercial hatchery of 91 per cent, while only 88 per cent of fry resulted from the Grand Lake Stream shipment.

From a consignment of 50,000 rainbow-trout eggs transferred from the White Sulphur Springs (W. Va.) station a hatch of about 93 per cent resulted. The output of the station was further augmented by the receipt of 70,000 eggs of the landlocked salmon from the Green Lake (Me.) station, which were incubated with a loss of about 4 per cent. All of the fry of the various species were distributed in New England waters, principally in Maine.

GREEN LAKE (ME.) STATION AND SUBSTATION.

[JOHN A. STORY, Superintendent.]

Operations in this field were confined to the work at the main station and the substation at Grand Lake Stream, Me., the collecting station at the Fish River Lakes being abandoned in favor of the Maine State Fish and Game Commission because of insufficient funds. The species handled involved the landlocked salmon, the brook trout, the smelt, and the small-mouthed black bass.

GREEN LAKE (ME.) STATION.

The work in connection with the landlocked salmon was taken up in October, when a pound net was placed in Green Lake for the capture of the spawning salmon. Fishing was continued from October 17 to November 12, and during the period 171 adult fish were taken. Of these 114 were females and 57 males, and 227,525 eggs were obtained. In addition 25,000 eggs were supplied the station from the State's hatchery at Oquossoc. Of the local collections 70,000 were shipped in the eyed stage for convenience in distributing fry and fingerlings to the various applicants in the State, and smaller numbers were supplied to applicants in other parts of the country. The remainder, with those received from the State, were incubated at the station for the replenishment of local waters.

Eyed brook-trout eggs to the number of 103,000 were acquired by purchase from commercial dealers, and an additional lot of 75,000 was received from the Pennsylvania Department of Fisheries and Game. The resulting fry were distributed in the waters of the State.

The efforts made to collect spawning smelt for propagation at this point were not successful. The cold rains occurring at spawning time apparently caused the fish to desert their customary spawning places in the tributary streams. An investigation of other ponds in the locality revealed similar conditions. The 300,000 eggs of this species obtained were incubated with but little loss.

Because of windy weather and the unusual depth of water in which nest-building occurred, but little was accomplished in obtaining small-mouthed bass fry from Green Lake waters. Some 22,000 were taken and supplied to applicants in other sections of the State. Fish of this species are not considered desirable in Green Lake, which is a natural habitat of the more highly prized landlocked salmon, and the removal of the bass fry for introduction into other more desirable waters meets with the approval of the local interests.

On the recommendation of the bureau the Green Lake station was closed as a permanent fish-cultural plant at the end of the fiscal year. It was estimated that not less than $25,000 would be required to replace the dam and water-supply flume, which were rapidly falling into decay, and in view of the fact that the water available at this site is of an inferior quality at best the discontinuance of the station seemed the only practical course to pursue. The bureau's property at Green Lake will be guarded by a custodian, and the more important items of fish-cultural work formerly prosecuted there will be continued as an auxiliary to the operations of the Craig Brook station.

GRAND LAKE STREAM (ME.) SUBSTATION.

A valuable addition to the rearing facilities at this substation was the acquisition, without cost to the bureau, through the courtesy of the St. Croix Paper Co., of control of the canal formerly used for the passage of boats over the quick water of Grand Lake Stream. Two ponds, each approximately 100 feet long by 25 feet wide by 3 feet deep, were constructed in this canal and proved entirely satisfactory for the purpose intended. Sliding gates at the point where the canal leaves Grand Lake control the flow of water through the ponds, and at slight cost additional ponds may be added to the present system.

At the beginning of the fiscal year there were on hand some 74,000 landlocked-salmon fingerlings, which were distributed in local waters during the summer months. The fall fishing operations resulted in the capture of 451 adult landlocked salmon, 192 females and 259 males. These fish averaged about 2½ pounds in weight, and approximately 252,000 eggs were obtained from them. One hundred thousand of these were shipped to St. John, New Brunswick, on behalf of the Canadian fishery authorities. The State of Maine furnished the station with 25,000 eggs of the same species from its hatchery at Oquossoc, and these, with the remainder from the local collections, produced fish for the restocking of local waters, about 100,000 fingerlings remaining on hand at the end of the year. During the spawning season unusually low water stages prevailed in both Dobis and Grand lakes. This condition was probably a factor in the reduced numbers of eggs taken, but it hardly explains the remarkably low average weight of the spawning fish handled.

The long-talked-of screen at the outlet of Grand Lake was completed during the year, the work being efficiently accomplished under the auspices of the Commissioner of Inland Fisheries and Game of the State of Maine. It will be of interest to note the effects of this installation on the salmon fishing of the waters involved.

In connection with the collection of landlocked salmon, a small number of brook-trout eggs was also taken, and 150,000 eyed eggs of this species were obtained from the State of Pennsylvania. Five thousand eggs of the local collections were delivered to a Massachusetts applicant; all of those remaining were incubated for local waters. In distributing the output the bureau is indebted to the local guides and boat owners who willingly carry the fingerlings to all of the important planting grounds, even the most remote, without expense.

ST. JOHNSBURY (VT.) STATION AND SUBSTATIONS.

[A. H. DINSMORE, Superintendent.]

Under this heading are included the main hatchery at St. Johnsbury, Vt., the substations at Holden and Swanton, Vt., and York Pond, N. H., and various egg-collecting points in Vermont and Maine. The work of the Swanton (Vt.) substations is outlined in connection with the propagation of the Great Lakes fishes on page 46.

ST. JOHNSBURY (VT.) STATION.

Five species of fish were propagated at this point, the brook, rainbow, brown, and lake trouts, and the steelhead salmon, the results being generally satisfactory. During the summer arrangements were made to collect brook-trout eggs on the Margalloway River and Parmancheence Lake in Oxford County, Me. As a preliminary to egg-collecting operations in this field a very satisfactory number of brood trout were captured and penned. Just at the approach of the spawning season there was evidence of malicious interference, which resulted in the liberation of the greater part of them. This being the third season's work in this region without any previous molestation no precautions had been taken to prevent such an occurrence. From the remaining fish only about 200,000 eggs were secured, half of which, by agreement, were turned over to the Guides Association after being eyed. The bureau's share of the fry hatched was released in adjacent waters with the exception of a lot of 10,000, which were reserved for rearing at York Pond. On account of the high quality of the eggs obtained and the rapid growth of the fry produced it is a matter of regret that the bureau's experience of the past three years has demonstrated the uncertainty of success in this field.

In order that all efforts might be concentrated on the work at York Pond and on the Margalloway River, it was decided to discontinue operations at Darling Pond and Lake Mitchell, in Vermont, but the owners of these waters were so urgent in their desire that the bureau continue its management of the work that it was finally agreed for them to assume the expense of operations and receive as compensation two-thirds of the fry produced from the egg collections at those points. The outcome of this arrangement was that the bureau secured about 290,000 eggs without incurring any expense in connection therewith. In addition to the collections referred to above 756,368 eyed eggs were purchased from a commercial establishment in Massachusetts, and 300,000 were transferred from the Pennsylvania Department of Fisheries and Game. For convenience in distributing the fry and fingerlings about 500,000 of the brook-trout eggs acquired were sent to the Holden substation. Besides the brook trout handled on behalf of the bureau some 40,000, the property of the Percy Sumner Club, were incubated for stocking Lake Christine, in New Hampshire. A consignment of brown-trout eggs were secured from the New York Conservation Commission, a portion of which were delivered to the State's hatchery at Roxbury, Vt., and 70,000 lake-trout eggs from the collections at Lake Dunmore were received from the Holden substation. Twenty-five thousand eggs of the steelhead obtained by employees of the State of Vermont in Caspian Lake were incubated at the station, the fry resulting being held at the disposal of the State.

Bass propagation at this station can not be termed successful so far as numbers are concerned, but quality has to some extent compensated for quantity, many of the bass distributed having attained a length of 4 to 6 inches. On account of the meager returns and insufficient funds nothing was attempted along this line during 1922.

Besides the usual distribution to applicants, liberal assignments of trout fry are made each year from this station for stocking

streams in the White Mountain National Forest. Such plants are carefully handled under the direction of the forest supervisor. The steelheads, the brown trout, and a small number of brook trout remained on hand at the close of the year.

HOLDEN (VT.) SUBSTATION.

At the beginning of the year there were on hand upward of 100,000 fingerling fish of various species that entered into the distribution of the fiscal year 1922. The substation was supplied with about 500,000 brook-trout eggs from the St. Johnsbury station. As customary, cooperative work with the State of Vermont addressed to the lake trout was undertaken at Lake Dunmore, resulting in the collection of 323,000 eggs, which, together with 25,000 of the same species shipped from Charlevoix, Mich., were incubated at the station. Fish-cultural work at Lake Dunmore is showing very gratifying returns. Each season a larger number of spawning fish are available.

The fish-cultural work at this substation during the fiscal year 1922 was unusually successful. All eggs handled produced a high percentage of fry, and the mortality among all species during the feeding period was light. In many seasons the mortality among both eggs and fry held in the spring water has been high, and this has been the subject of a number of investigations seeking the cause and the remedial measures that should be applied. During 1921 a new system of aeration was installed, which may have been an important factor in the excellent results obtained during the fiscal year 1922.

YORK POND (N. H.) SUBSTATION.

Actual fish-cultural operations at this point have been confined to the rearing of fry transferred from St. Johnsbury, Vt., some experiments in hatching brook-trout eggs in gravel, and the feeding of the adult fish in the pond. The work accomplished toward the development of the site for its ultimate object with the small amount of funds available is gratifying and reflects credit on the superintendent in charge of the work and his subordinates. The more important structures completed during the year are the cement dam diverting the water of Cold Brook to York Pond and a ditch carrying this water across the crest of an intervening ridge. From the ridge the water finds its way across a bottom of about 4 acres into York Pond. Eventually this 4-acre bottom will be converted into additional pond space. A control dam, also of cement, at the outlet of York Pond permits control of the water level of the pond, and one of the spillways in this dam has been continued to form a pit for a Poncelet wheel, which will furnish power for a fish-food chopper, dynamo, and possibly a wood saw.

During the winter after the work ceased a caretaker left in charge of the property cleaned the underbrush from the margins of York Pond, "slashed" two bottoms, which, with the completion of the plans, will be flowed, and completed much other work of a similar nature. In the course of the construction work a number of springs have been uncovered. The flow from these when concentrated will

furnish in connection with the flow from the pond a water supply of ample volume and, within reasonable limits, under control as to temperature throughout the year. It is expected that during the coming year the site will be sufficiently developed to permit of egg collections being undertaken successfully.

NASHUA (N. H.) STATION.

[WALDO F. HUBBARD, Superintendent.]

The year's distribution of fish from this station amounted in the aggregate to 2,008,030 of the following species: Brook trout, rainbow trout, lake trout, landlocked salmon, small-mouthed black bass, yellow perch, and pike perch. With the exception of some 10,000 rainbow-trout eggs and 125,000 brook-trout eggs, which were obtained from the small number of brood fish maintained at the station, and the small-mouthed black bass resulting from natural spawning in Sunapee Lake, all of the fish distributed were produced from eggs purchased from commercial fish-culturists or transferred from other stations. The pike perch and yellow perch were received from the Vermont station on Lake Champlain, the lake trout from Holden, Vt., the landlocked salmon from Green Lake, Me., and the rainbow trout from Wytheville, Va. The brook-trout eggs were purchased from commercial fish-culturists in the New England States. There were no unusual circumstances attending the incubation of the eggs or the distribution of the resulting fish.

In discussing the affairs of this station it is considered proper to mention the deplorable condition of the bureau's property. The hatchery building—a temporary structure, built with no view of permanency—is at present a very dilapidated affair. The rearing ponds, which were originally constructed with plank sides, are in a similar state of decay and are of no value to the station. If the station is to continue its usefulness, funds for rather extensive repairs must be provided at an early date.

COMBINATION TROUT AND POND FISH-CULTURAL STATIONS.

The five stations in this group produced for distribution during the year 5,447,922 eggs, fry, and fingerling fish, as compared with 4,654,835 in 1921. The aggregate output by species for each of the two years is indicated in the following table:

Species.	Output.		Species.	Output.	
	1922	1921		1922	1921
Brook trout	1,685,100	1,664,950	Sunfish	125,945	62,355
Rainbow trout	3,402,487	2,583,244	Crappie	4,290	14,332
Small-mouthed black bass	43,383	112,591			
Large-mouthed black bass	147,774	121,978	Total	5,447,922	4,654,835
Rock bass	38,943	95,385			

These figures represent such species of fish as are actually produced at the stations and do not include fishes produced from eggs transferred from other points. The inclusion of such species would

increase the aggregate for 1922 by 4,960,000, which includes 4,900,000 yellow perch and 60,000 pike perch distributed, and for 1921 by 500,058, representing 500,000 pike perch and 58 yellow perch distributed.

ERWIN (TENN.) STATION.

[A. W. KEESECKER, Superintendent.]

During the year a number of improvements were made in the water supply and drainage systems and in certain of the ponds. Among the more important items accomplished were the installation of a new water-supply line, replacing the line in use for many years; the construction of a retaining reservoir in the spring branch from which water is now conducted to increase the flow in the stock ponds; a retaining wall around the main spring, protecting it from surface drainage; and certain changes and improvements to pond outlets.

Six species of fish came under artificial propagation at this station during the year, namely, the rainbow trout, brook trout, large-mouthed black bass, small-mouthed black bass, rock bass, and sunfish. In addition to those enumerated a small number of adult catfish transferred from the Bullochville (Ga.) station were on hand but were entirely nonproductive.

The spawning period of the rainbow trout extended from October 27 to January 10, the brood stock of about 1,600 female fish producing, in round numbers, 1,250,000 eggs. Of the number retained at the station 89 per cent produced healthy fry. The brook trout appearing in the distribution records were the result of eyed eggs acquired by purchase from commercial trout breeders in the New England States. Heavy rains and other unfavorable weather conditions at the spawning time were important factors in curtailing the production of the pond fishes, and a decrease in their output is to be recorded.

The investigator from the division of scientific inquiry continued his studies and experiments in connection with the spawning of the rainbow trout mentioned in last season's report, and though certain points of interest and value are indicated, no definite conclusions have as yet been established. Experiments looking to the improvements in certain conditions affecting the fish held in the station ponds were also conducted. These experiments were along the line of attempting to change the chemical properties of the water by the addition of certain acids. The results, however, were negative.

MANCHESTER (IOWA) STATION.

[F. E. HARE, Superintendent.]

A successful season in fish culture at the Manchester (Iowa) station is to be recorded. The brood stock of all species remained in good health throughout the year, and there was a satisfactory increase in the numbers of fish produced for distribution, the increases being especially noticeable with the rainbow and brook trouts.

The species handled were the rainbow trout, brook trout, steelhead, small-mouthed black bass, rock bass, sunfish, and pike perch, with

an aggregate output of approximately 1,000,000, and considerable numbers of fish remaining on hand at the end of the year to augment the brood stock or for later distribution. The brood stock of rainbow trout consisted of 1,900 adult females, some 900 of which were 2 years old. These fish yielded 512,000 eggs, and from those eggs retained at the station 95 per cent produced fry.

The brook-trout brood stock contained in round numbers 1,400 females, 1,000 of which were yearlings. From these fish 145,000 eggs were taken, all of which were incubated with a loss of 6 per cent. The output of this species was increased by the purchase of some 700,000 eyed eggs from commercial breeders. Steelhead eggs to the number of 25,000 were received from the Birdsview (Wash.) station and incubated without undue loss; the resulting fry will be retained for brood stock.

Weather conditions were unfavorable during the spring spawning season of the pond fishes, and none of them produced as prolifically as might otherwise have been expected. Successful results were obtained from the rock bass, 72 mature breeders of this species producing 16,650 fry and fingerlings for distribution. Pike-perch eggs to the number of 75,000 were received from the Lake Erie station, from which 60,000 fry were produced.

Two concrete ponds, each 21 feet wide by 32 feet long, and 2½ feet deep, with concrete sides, were made by combining three of the original nursery ponds into one of these. A portion of the bottoms was left in earth to induce the growth of pond vegetation. Each pond is supplied by three 1½-inch pipes, and they will be used for holding the brood stock when necessary, as well as for the accommodation of fingerlings at other times. Cement kettles were constructed in five of the breeding ponds, and all ponds at the station are now equipped with such kettles.

NEOSHO (MO.) STATION.

[FRED J. FOSTER, Superintendent.]

The station's output of rainbow trout was 57 per cent in excess of that of any previous year, notwithstanding the continued presence of a persistent parasitic affection among the older adults, making it almost impossible to secure good eggs from fish over 3 years of age. During the spring of 1922 an epidemic of "fluke parasites" attacked the fins and gills of the fingerling fish, resulting in some losses. This is the first authentic record of the appearance of the disease here, though from evidence at hand it is believed to have existed to some extent a number of years ago. After experimenting with several remedies, including potassium permanganate, the trouble was finally overcome through the application of a 1 to 15 solution of pure cider vinegar and water. The rainbow trout appears to be finely adapted to the waters of Missouri and the adjacent region, and frequent reports of excellent captures are received, many of the fish taken weighing from 4 to 8 pounds.

In order to determine the possibilities of brook-trout propagation at this station, a consignment of fingerlings and yearlings of that species was received for a brood stock from the Manchester (Iowa) station late in the year. On arrival the fish were found to be

thoroughly affected with gill trouble, a condition that is troublesome at Manchester. The effect of the change to this station will be carefully noted, and if it develops later that brook trout can be successfully grown here a brood stock will be built up and maintained as a source of egg supply for other stations of the bureau.

A recent investigation of the brood pond fishes by the bureau's pathologist conclusively demonstrated a fact that has been evident for some time, namely, that these fishes as well as the trout are affected with a cystic degeneration of the ovaries, and to this unhealthy state is no doubt attributable the greatly reduced output in recent years. Notwithstanding the presence of this disease the outcome of the year's operations with the pond species was successful to an unusual degree, over 100,000 fingerling fish being produced and distributed, and the black-bass production increased by 37 per cent over the output of the previous year. This favorable showing was made possible largely by the congenial weather prevailing during the spring spawning season, a condition that has been observed to occur on an average of once every eight years. During the spring a consignment of several million eggs of the yellow perch was received at Neosho from the bureau's Potomac River hatchery. Part of these eggs were turned over to the Missouri Fish and Game Department and the remainder were incubated, the loss in hatching amounting to 10 per cent. The efforts frequently made in the past to inaugurate yellow-perch propagation at this station have always resulted in failure, ovarian trouble making its appearance within the course of a year's time, with a consequent falling off in egg collections. As many of the waters in this region are adapted to the yellow perch, it is hoped that shipments of eggs of this species can be made annually from other hatcheries of the bureau.

WHITE SULPHUR SPRINGS (W. VA.) STATION.

[EDWARD M. HAYNES, Superintendent.]

The year's fish-cultural activities at this station were very generally successful, the aggregate output of the station being the largest in its history by more than 500,000 eggs, fry, and fingerling fish. Although the output of rainbow trout showed the most noticeable increase, there was also a larger production of the other species propagated. The brood stock of rainbow trout, of which 3,600 were females from 4 to 6 years old, yielded 2,210,000 eggs. Shipments of these to the number of 860,000 were made to applicants and to other stations of the bureau after reaching the eyed stage, and 80 per cent of the remainder produced healthy fry.

Because of the high mortality that occurs every year among the adult fish at spawning time only a comparatively small number of brood brook trout have been maintained at this station. The 700 three-year-old fish of this species on hand during the fall of 1921 yielded 115,000 eggs; 125,000 eggs from wild brook trout were received from the Springville (Utah) station; 450,000 were acquired by purchase; and the State of Pennsylvania furnished 300,000 in exchange for eggs of other species. The station also incubated 100,000 brook-trout eggs belonging to the State of West Virginia. Some 2,500 fingerlings resulting from the Utah eggs were retained at the station to be reared for a brood stock.

Because of the large demand for the pond fishes in this vicinity repeated efforts have been made to propagate the large-mouthed and small-mouthed black basses and other similar species. Climatic conditions appear to be the main barrier to success in such work. Frequent and sudden fluctuations in both air and water temperatures incident to the rather high elevation result each season in a very considerable loss of both eggs and young fish. During the fiscal year 1922 the results attained from the propagation of the so-called pond fishes were more successful than usual, though not altogether satisfactory. Seventy adult small-mouthed black bass produced 40,000 fry and fingerling fish. The large-mouthed black bass made a much better showing, the nesting of 23 brood fish resulting in approximately 66,000 small fish for distribution. The crappie failed entirely to reproduce, while 125 adult sunfish produced some 16,600 fingerlings. The brood stock of rock bass, 140 in number, appeared to be in excellent condition and a fair number of young were expected, but only 5,000 were available at the distribution period.

WYTHEVILLE (VA.) STATION.

[G. A. SEAGLE, Superintendent.]

During the extended spawning period—October 13 to March 31—732,500 rainbow-trout eggs were obtained from the brood stock, which consisted of 3,300 female fish, about one-third of the number being 2-year-old fish at their first spawning. Approximately 463,000 of the eggs were retained at the station for incubation, and 90 per cent of them produced fry; the remainder were shipped to various States and foreign governments and to other stations of the bureau. The brook trout distributed from this station were produced from 100,000 eggs that were acquired by purchase and incubated with but a nominal loss. In the early spring, however, the fingerlings suffered a heavy mortality, and but 53,000 were available for applicants.

The year's work with the pond fishes represents a fair average of the work of the past few seasons, although it is far from satisfactory, and it is hoped that certain changes instituted during the year in the water-supply system and drainage and along other lines will effect a material increase in the output for the next fiscal year. The more important improvements included a new settling tank and filter and the completion of the nursery building mentioned in the report for the fiscal year 1921.

After heavy rains the spring water at Wytheville becomes very turbid, owing to the seepage of surface water into the spring source. This water when coming at certain stages of development of the brook-trout fry causes serious losses, and during the spring of 1921 practically the entire stock of brook trout was lost. The effect on the rainbow trout has not been so serious. To overcome this difficulty of turbid water, a concrete settling tank was constructed, approximately 20 feet wide by 70 feet long, with a cement partition extending longitudinally through the center to a point near one end. This makes it necessary for the water to flow approximately 140 feet, after which it enters a sand filter having a surface area of 80 square feet.

An alum-dropping device was placed near the spring and a dosage of 1 grain of alum to each 2⅛ gallons of spring water was supplied to the settling tank. This rate of feed equals 1 part of alum to 124,000 parts of water, and since the untreated spring water entered the settling tank at the rate of 80 gallons per minute it required approximately 8 pounds of alum per 24 hours. The untreated spring water was so turbid that fingerling fish could not be seen in the troughs, but the treated water entered the hatchery as clear as crystal. The untreated spring water contains sufficient alkali in solution to react completely with the small amount of sulphate of alumina necessary to remove impurities, leaving sufficient alkaline nitrate to prevent any "aftercoagulation" in the filtered water. A practical test has been made of this system, and sufficient water was filtered to supply 350,000 fingerling trout No. 2. Since it clears the water, no matter how turbid, it is believed that brook trout can now be raised successfully at the station.

A device, believed to be unique, for cleaning the sand used as the filtering element was also tried out successfully. It consists of a spiked tooth rake, which may be drawn back and forth through the sand by means of a windlass sprocket wheel and chain. The flow of water in the sand bed of the filter is reversed during the cleaning process and is discharged into the waste ditch by opening a valve.

POND FISH-CULTURAL STATIONS.

The work of the remaining group of stations, seven in number, was concerned with the propagation of the so-called warm-water pond fishes. The aggregate output of such fishes from these stations during the year amounted to 2,702,480 fry and fingerlings, as compared with 2,473,711 in 1921 and 1,837,508 in 1920. Though the increases noted in the production of such fishes are of interest, indicating, to some extent at least, the application of improved fish-cultural methods as a result of the knowledge gained from past experience and from special investigations, such increases are by no means adequate to meet the pressing needs for a larger output of the species involved. For a long time the bureau has found it very difficult to honor requests for the pond fishes with promptness because of the limitations imposed by natural conditions on their culture. This difficulty has assumed larger proportions with the constantly increasing interest in fish culture and the increased demands for fish for stocking barren or newly formed bodies of water or for the restocking of such waters as have, for various reasons, become depleted of their indigenous fish life. At present all fish of this class that can be produced with the existing facilities are assigned from one to one and one-half years in advance, and it is only in rare instances that requests for the pond fishes can be honored during the fiscal year in which they are submitted. Some means for an increased output of the pond fishes continue to be an urgent requirement of the fish-cultural division.

COLD SPRINGS (GA.) STATION.

[CHARLES A. BULLOCK, Superintendent.]

The year's output from this station comprised 213,910 fry and fingerling fish, as follows: 118,185 large-mouthed black bass, 87,200

sunfish (bream), 8,200 catfish, and 325 crappie. The sunfish distributed were produced in Harris Pond and transferred to the Cold Springs station at intervals between August and October as they attained suitable size for handling. They were removed from the pond by means of a 100-foot seine of ¼-inch mesh, which was drawn slowly through the water in order to allow the smaller fish to escape through the mesh. The season's work with this species was the most successful ever experienced at the station, but the outcome of the work with the crappie was far from satisfactory. In the hope of improving conditions the brood stock of this species was transferred to another pond in the spring of 1922, and at the close of the year a considerable number of fingerling crappie were seen in this pond. The ouput of catfish was also derived from Harris Pond. These fish were secured in connection with the sunfish collections, and a sufficient number were obtained to fill all applications on hand.

In an effort to check the increasing losses among the adult large-mouthed black bass, which have recently assumed alarming proportions, and with the view also of reducing the cost of their maintenance, the food supply of this species was changed at the beginning of the year, beef heart being substituted for fresh mullet, which has been the exclusive food for a long period of years. The change proved detrimental, as the mortality increased during the first five months of the year, and this heavy loss of brood stock resulted in a curtailed output of young bass. The loss of adult fish, externally appearing to be in prime condition, has been an unfavorable factor at this station for some time. The greatest mortality has heretofore occurred in August, but it was so heavy this year during the spring months that a resumption of the fresh mullet diet was resorted to with considerably reduced losses. It is presumed that the food of the adult bass was deficient in some element present in the natural food supply at the more successful stations, being apparently present in insufficient quantities in the fresh mullet and lacking to a still greater extent in the beef heart. This was probably the cause of the loss of fish. It is possible that the missing substance is phosphate of lime. This important element would undoubtedly be present in sufficient quantity in waters well stocked with suitable natural food for the fish, and it is proposed to conduct a control experiment by adding ground green bone to the beef heart. On account of the great demand for bass, the station force undertook to make collections during May in a large lake located near Birmingham, Ala., but the attempt was given up after securing only 12,000 fry as a result of 25 days' effort.

EDENTON (N. C.) STATION.

[DELL BROWN, Superintendent.]

The more important work of this station—that addressed to the propagation of shad and river herring—is discussed on page 54. In addition to the output of such species the station produces and distributes every year a comparatively small output of large-mouthed black bass and sunfish. The ponds available for this work are not particularly well suited to it, being too shallow and of insufficient area for the best results, and although the pond-fish-cultural work is to some extent an incidental item in the affairs of the station even

the small numbers of such fish produced become of importance in view of the heavy demand for them as compared with the limited facilities for their propagation. The station's output of pond fishes for the fiscal year 1922 aggregated 50,675.

LOUISVILLE (KY.) STATION.

[C. W. Burnham, Superintendent.]

The aggregate output of this station for the year was in excess of 600,000 fry and fingerling fish of the following species: Large-mouthed black bass, small-mouthed black bass, rock bass, sunfish (bluegill), and yellow perch. Special attention has been given to the propagation of the small-mouthed black bass, and there has been a gradual increase in the output of that species for the past three years. During this fiscal year 345,000 advanced fry and fingerlings of this species were produced and distributed to applicants. It is of passing interest to note in connection with this work that 143 small-mouthed black bass adults from Lake Erie, which were placed in spawning ponds at the station just a few days before the mating season, produced 114,000 fry, although during the previous year adult fish from the same source were placed in the ponds in October and failed entirely to spawn. The brood stock of 100 large-mouthed black bass, though apparently in excellent condition, was practically nonproductive, only one school of fry being observed. This is probably attributable to the advanced age of the brood stock. The work concerned with the rock bass and the sunfish was successful to the extent that the numbers of those species produced compare favorably with the output of previous years. The stock of yellow perch, consisting of 315 small-sized adults, produced 50,000 fry, and because of the unsatisfactory returns from these fish over a period of several years, all of them were liberated in the Ohio River at the end of the spawning period. As the yellow perch appears to be a highly prized fish in the locality, 200,000 eggs of this species were transferred to the Louisville station from the Potomac River, and a satisfactory percentage of fry was obtained from them for distribution.

MAMMOTH SPRING (ARK.) STATION.

[W. S. Vincent, Superintendent.]

The work of improving the station pond system, which has been in progress for the past two years, was carried forward as time permitted. Such work included remodeling of the standpipes, construction of kettles in some of the ponds, and the formation of one large pond by throwing four small ponds of the old system together. The extreme eastern section of the levee, which runs parallel to the creek, was strengthened by riprapping that portion that is most exposed to the ravages of drift during high-water periods; and, as a precaution, a ditch 1½ feet wide by 2 feet deep was cut in which to start the wall, thus insuring the new rock work against slipping. As the base of the new construction is from 8 to 10 feet wide and from 3 to 5 feet in width at the top, it is believed it will

withstand any freshet that is liable to occur in Warm Fork. From this point west for about 100 feet the levee was brought to grade, thus obviating all possibility of inundation of the station grounds during floods.

During the fall the brood stock of all species of fish handled at the station was augmented, partly through transfers of fish from northern points and partly through collections from local waters, such collections also including supplies of minnows as a source of food for the adult fish.

In order that they might be under close observation, the 100 small-mouthed black bass received from Lake Erie were placed on arrival in the smaller of the two ponds maintained for the culture of this species. In the course of the spawning season in the spring 12 nests of various sizes were noted in this pond, all being below the average except two. Each of these yielded 4,000 fry, while the fry proceeds from the 12 nests amounted to 12,000. In the larger pond, used for the spawning of the 200 older fish, 25 nests were occupied, and 49,600 advanced fry and fingerling fish were the net result. From observations made during the season it was ascertained that the eggs hatched in four days, in an average water temperature of 69¼° F. and that the maximum number of fry from a single nest was 6,000, the average for the entire number being 3,000. The spawning season began on April 5 and continued at irregular intervals to May 2.

From the spawning of the large-mouthed black bass, which commenced about two weeks later, nearly 39,000 advanced fry and fingerlings Nos. 1 to 3 were collected and distributed before the close of the year, and a considerable number of young bass were still in the pond on that date.

The outcome of the year's work with the rock bass is deemed noteworthy, over 15,000 fingerling fish No. 2 being seined late in the fall from the pond occupied during the previous spring by 60 brood fish of that species. After supplying about 4,000 of these fingerlings to applicants the remainder were stored for spring distribution in one of the newly constructed ponds. Unfortunately the water temperature in this pond was not under control, and before the fish could be collected for shipment in the spring they were subjected to unseasonably high temperatures, with a consequent loss of a large proportion. During April and May the nests of the rock bass were held under close observation to determine, if possible, the number of fry produced from a single nest. A fry container was used to confine the fish, which during the early stages were about three-sixteenths of an inch long. They were fed at frequent intervals on Daphnia. Just before the conclusion of the experiment, however, the cheesecloth walls of the retainers were wrecked by high winds, permitting all the fish to roam at large in the pond.

Close observation was kept on a brood stock of 75 crappie maintained during the year, but without securing any information as to the time or extent of their spawning. However, in the process of drawing down the bass pond adjoining the one containing the crappie, 54 young crappie were gathered from among the bass.

ORANGEBURG (S. C.) STATION.

[G. W. N. BROWN, Superintendent.]

Though special efforts were put forth to increase the output of this station, resulting in an increased production of approximately 50,000 fish, principally large-mouthed black bass, the outcome of the season's work was disappointing.

After a particularly careful preparation of the spawning ponds the 436 large-mouthed black bass comprising the brood stock were installed therein early in February. As the breeding fish were in excellent condition, a large crop of young bass was confidently expected. The first spawning occurred in February, when a number of nests were occupied, but because of the prevailing high winds and the resulting turbidity of the water none of these nests produced fry. No further nesting was observed until the middle of March, but from that time until May 10 spawning was in progress at intermittent intervals, with the result that 257,786 young fish were available for distribution. High winds and rains were prevalent throughout the entire season, both influences reacting to the detriment of the work. A rainfall of 30.05 inches was recorded at the station between January 1 and June 30, 1922.

The outcome of the work addressed to sunfish propagation represents an average season, but in view of certain changes whereby an increased pond area was provided for this species a considerably increased production may reasonably be expected during 1923.

The crappie and the rock bass fail to thrive in artificial environment at Orangeburg. Both of these species refuse artificial foods and fail to avail themselves of such natural food as may be present in the water supply. As a consequence, they soon become emaciated and die. More satisfactory results are expected from the warmouth bass, with which two of the newly constructed ponds were stocked.

In addition to the fish-cultural work much was accomplished along the lines of improving ponds and other property. Among the more important items of this work may be mentioned the construction of new ponds, extensive repairs to pond embankments, and improvements to the surface-drainage system, with the view of protecting the ponds, roads, and grounds from surface drainage during periods of rain.

SAN MARCOS (TEX.) STATION.

[MARK RILEY, Superintendent.]

The past year's work has been the most successful in the history of the station. The total output of all species amounted to over 700,000 fish, ranging in size from No. 1 to No. 8 fingerlings, over 500,000 being large-mouthed black bass. Southern Texas is a natural habitat of the black bass, and it is believed the conditions fully warrant an increase in the scope of bass propagation in this section of the State. Although all natural surroundings are favorable to bass production, the same can not be claimed with reference to the crappie. Repeated efforts have been made and various methods tried in the propagation of this fish, but all attempts along that line have

proved unsatisfactory. If work with the crappie is to be continued at this station, it is believed a pond should be prepared and set aside especially for that purpose. Under present arrangements a few thousand are collected annually from the ranchmen's stock-watering ponds and distributed to applicants, such ponds having been stocked by the bureau with the understanding that part of the young fish realized were to be utilized in its distribution work. Crappie seems to do well in these roily water ponds, but the existing arrangement is unsatisfactory to most of the ranchmen who are averse to giving up the fish after their ponds have become stocked. Moreover, many of these ponds evaporate during the summer months, and dependence can not be placed upon them for supplies of young fish for distribution.

The rock bass does not seem to thrive in this part of Texas. On several occasions in the past brood ponds stocked with this fish have been flooded, permitting many of the fish to escape into the San Marcos River, but as very few rock bass have ever been observed it is assumed that the species is not adapted to the region. Considerable work was accomplished during the year with the sunfish, and a sufficient number were produced to fill all applications, the output numbering about 86,000.

During the year an agreement was entered into with the State whereby it is expected to prevent duplication of effort in the distribution of fish. This agreement comprehended the division of the State for fish-cultural purposes into two nearly equal parts. All applications emanating from the northern section were to be honored from the State hatchery at Dallas, while the bureau's San Marcos hatchery was made responsible for requests from the southern section. Theoretically, at least, this arrangement tends to reduce distribution costs to both agencies concerned. Just what its practical results may be is at this time uncertain.

During the winter of 1922 an experiment was conducted to determine the possibility of hatching rainbow-trout eggs at the San Marcos station with a view of furnishing rainbow trout for Medina Lake, at San Antonio, and Comal Creek, at New Braunfels, Tex., both of these bodies of water having been represented to the bureau as being suited to the species. For this purpose 15,000 eyed eggs were forwarded from the Neosho (Mo.) station, arriving on January 26 in apparently good condition. Owing to a difference of approximately 35° in temperature between the eggs in the case and the hatchery water it took about 24 hours to temper the eggs. This was done with the utmost care. Two kinds of trays were employed in the hatching operations, about half the eggs being placed on trays of fine mesh and the remainder on trays covered with the ordinary oblong mesh. A considerable death rate prevailed among the eggs before hatching commenced on January 22, and it was observed that all fish hatched succumbed almost immediately, the entire consignment perishing either as eyed eggs or as fry. As it appeared impracticable to incubate the eggs successfully at the San Marcos station the requests for Medina Lake and Comal Creek were subsequently honored by making shipments of rainbow-trout fingerlings from one of the trout stations.

TUPELO (MISS.) STATION.

[DAVID DAVIES, Superintendent.]

The fish distribution from this station during the year included the large-mouthed black bass, the sunfish, and the crappie. The aggregate output in round numbers amounted to 385,000, and approximately 600 requests from applicants in the States of Mississippi, Louisiana, Alabama, Arkansas, and Tennessee were honored, leaving an indeterminate number of fish remaining on hand at the close of the year.

As opportunity offered without interference with fish-cultural operations or without involving any additional expense, work was continued on the construction of the new pond, and about 290 feet of the south embankment was finished. This pond will have an area of 2.14 acres, and about 140 feet of additional embankment will be required to complete it.

CENTRAL STATION AND AQUARIUM, WASHINGTON, D. C.

[L. G. HARRON, Superintendent.]

In an effort to maintain a display of fish life for the edification and information of the public, several difficulties were encountered in the course of the year that detracted considerably from the usual effectiveness and value of the exhibit. The rapid increase in the population of Washington during recent years, with the consequent increase in water consumption, has taxed the city's water conduits to the limit of their capacity. This condition led the President early in the fiscal year to direct all Government departments to curtail as far as practicable their use of water. In compliance with this order the bureau abandoned for the warm period of the year its display of the trouts, salmons, and grayling, all of which require a considerable flow of cool water, and confined its exhibit to the so-called warm-water fishes, the latter requiring only a comparatively small flow of water. Upward of 1,000 fish ranging in size from fingerlings No. 3 to adults were disposed of, the adults being turned over to the New York Aquarium and the smaller fishes planted in public waters. Further difficulty arose during the early spring when the health authorities found it necessary to use chlorine as a sterilizing agent in the city water supply, it being understood that this is the first time in the history of Washington that such a course has been necessary. The effects of this agent were immediately noticeable among the fish at Central Station. Within 48 hours after its introduction in the water all the eggs and fry on hand were dead, the loss amounting to more than 2,250,000. The adult fish were also affected, the trouts succumbing first, though such species as the sturgeon, the catfish, the black basses, and the crappie were lost also.

To demonstrate for the benefit of the visiting public the various methods and apparatus used in the incubation of fish eggs and the rearing of fry, efforts are made to keep eggs and fry of the various species propagated on exhibit at such times as is possible. The

aggregate number of fish eggs thus handled during the fiscal year 1922 was as follows:

Chinook salmon	11,100
Atlantic salmon	19,950
Brook trout	49,870
Rainbow trout	50,000
Lake trout	1,000,000
Whitefish	600,000
Shad	1,311,000
Total	3,041,920

Fry to the number of 2,300,500 were hatched from these eggs, but practically all of them were lost, as described above.

An interesting occurrence in connection with the aquarium fishes was the spawning of a pair of Potomac catfish. On the morning of June 12 it was noted that a pair of Potomac catfish (*Ameiurus catus*), which had been held in one of the small aquariums since April 29, had prepared a nest in the gravel covering the slate bottom of the tank, and the female had deposited therein a glutinous mass of eggs. The number was roughly estimated at 600, but this proved to be considerably below the actual number. The male fish immediately assumed charge of the nest, working over it constantly, agitating the water over the eggs with a quick gentle motion of the pectoral, ventral, and caudal fins. He maintained his vigil from the time the eggs were deposited until the fry were hatched and were strong enough to leave the nest. At no time did he permit the female to approach the nest. His labors were evidently for the purpose of keeping the eggs free of sediment and circulating the water through the mass. When first deposited, the eggs were of a pale-blue color. The incubation period was eight days in a mean water temperature of 75° F.

When the fry first emerged from the egg, they were about one-fourth inch in length, transparent, and of about the same color as the egg. They remained on the nest for the first six days, at the end of which time they began rising a few inches above it, at first falling back almost immediately, but gradually remaining longer above the bottom. By the eighth day they were strong swimmers and seemed about to scatter. On the ninth day they were transferred from the aquarium to a hatching trough, numbering at that time 1,453 by actual count. In the trough they received food (beef heart) twice a day, which they took readily. They made excellent growth. When nine days old, they averaged five-eighths of an inch in length and by the end of June, when 19 days old, 1 inch.

Part 2.—DISTRIBUTION OF FISH AND FISH EGGS.

[E. C. Fearnow, Superintendent of Fish Distribution.]

The total net output of the bureau's stations (see table, p. 8) for the fiscal year 1922 (5,125,101,320 fish and fish eggs) was widely distributed, shipments of fish and eggs being made throughout the States and to Alaska and Hawaii and assignments of eggs to Canada, Czechoslovakia, and Switzerland. About 99 per cent of the output was made up of fish and fish eggs of commercial species, which were planted in waters where the egg collections were made, except in

instances where the eggs were shipped to State fish commissions (see p. 88). In the list of commercial species are included fishes rescued from the landlocked sloughs along the Mississippi River (see p. 10).

The species propagated for the purpose of stocking interior waters are brook trout, rainbow trout, black-spotted trout, large-mouthed black bass, small-mouthed black bass, rock bass, sunfish, crappie, and catfish. The great economic value of this work is attested by the large number of favorable reports received from organizations and individuals concerning plants of fish made in waters, many of which contained no fish life prior to such introduction by the bureau (see discussion and tables on p. 111).

TABULAR SUMMARIES OF DISTRIBUTION.

DISTRIBUTION TO ALL APPLICANTS.

The following table shows in summarized form the numbers and species of fish and fish eggs of the net output of the hatcheries for the fiscal year 1922 that were delivered to applicants.

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922.

[Asterisk (*) denotes eggs; dagger (†), fry; all others are fingerlings or yearlings.]

UNITED STATES AND TERRITORIES.

State and species.	Number.
Alabama:	
Catfish	5,260
Large-mouthed black bass	†60,500
	80,169
Rock bass	2,500
Small-mouthed black bass	650
Sunfish	51,950
Alaska:	
Humpbacked salmon	210,000
Sockeye salmon	*150,000
	†28,400,000
	51,820,000
Arizona:	
Catfish	495
Crappie	178
Large-mouthed black bass	390
Rock bass	200
Sunfish	105
Arkansas:	
Crappie	725
Large-mouthed black bass	†14,000
	32,870
Rainbow trout	28,025
Rock bass	4,042
Small-mouthed black bass	†63,000
	1,000
Sunfish	21,900
Yellow perch	†300,000
California:	
Catfish	960
Chinook salmon	5,872,200
Colorado:	
Black-spotted trout	349,000
Brook trout	†471,000
	2,437,550
Catfish	2,225
Crappie	50
Lake trout	25,000
Large-mouthed black bass	6,790
Loch Leven trout	20,000
Rainbow trout	112,600
Sunfish	1,000
Connecticut:	
Brook trout	47,000
Catfish	10,000
Crappie	80
Flounder	†19,354,000
Connecticut—Continued.	
Large-mouthed black bass	495
Pike perch	†1,000,000
Small-mouthed black bass	621
Yellow perch	†200,000
	525
Delaware:	
Brook trout	1,200
Large-mouthed black bass	1,050
Rock bass	540
Sunfish	60
Georgia:	
Brook trout	†10,000
Catfish	3,150
Crappie	475
Large-mouthed black bass	†13,000
	84,285
Rainbow trout	67,600
Small-mouthed black bass	100
Sunfish	48,200
Hawaii: Rainbow trout	*51,000
Idaho:	
Black-spotted trout	10,500
Brook trout	15,950
Chinook salmon	224,000
Landlocked salmon	*5,000
Rainbow trout	*125,000
	87,000
Whitefish	*1,000,000
Illinois:	
Buffalo fish	*19,292,000
	380,200
Carp	301,460
Catfish	572,115
Crappie	315,665
Fresh-water drum	10
Large-mouthed black bass	8,622
Pike and pickerel	50
Rock bass	240
Small-mouthed black bass	1,500
Sunfish	744,815
White bass	1,560
Yellow perch	25
Miscellaneous fishes	20,000
Indiana:	
Carp	110
Catfish	3,150

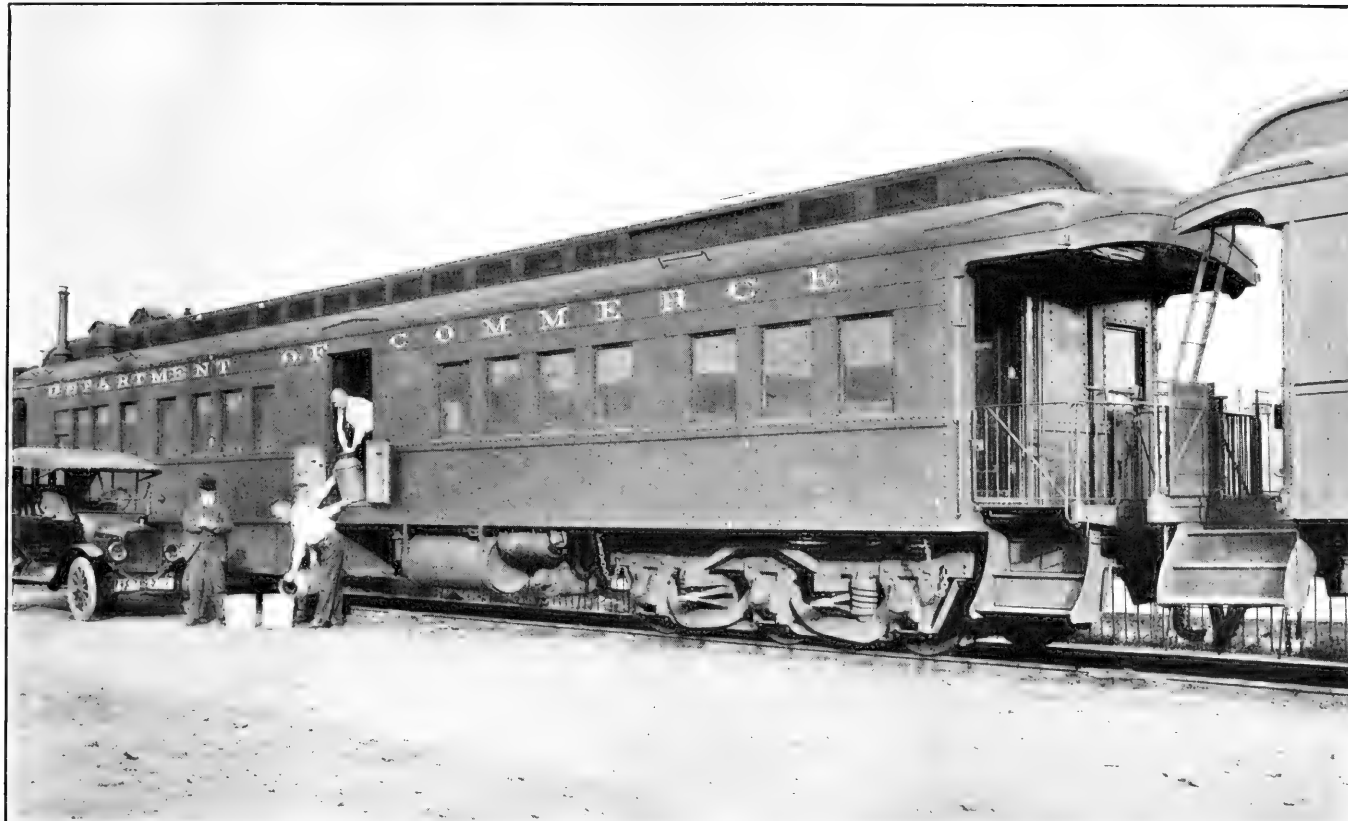

FIG. 3.—Applicant receiving fish from Bureau of Fisheries distribution car attached to regular passenger train.

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Indiana—Continued.	
Crappie	2,820
Large-mouthed black bass	9,342
Pike perch	*13,800,000
	†3,000,000
Rainbow trout	†36,000
	600
Rock bass	1,400
Small-mouthed black bass	†151,000
	22,575
Sunfish	17,100
Yellow perch	525
Iowa:	
Brook trout	47,400
Buffalo fish	*37,764,250
	1,709,855
Carp	10,799,690
Catfish	16,002,860
Crappie	8,844,235
Fresh-water drum	213,150
Lake trout	*50,000
Large-mouthed black bass	62,296
Pike and pickerel	18,140
Pike perch	*5,100,000
	†60,000
	340
Rainbow trout	*206,000
	21,600
Rock bass	2,800
Sunfish	20,204,019
Warmouth bass	1,860
White bass	7,190
Yellow perch	42,275
Miscellaneous fishes	6,337,445
Kansas:	
Catfish	3,100
Crappie	220
Large-mouthed black bass	5,470
Sunfish	400
Yellow perch	*5,000,000
Kentucky:	
Catfish	3,000
Crappie	2,740
Large-mouthed black bass	1,995
Rock bass	1,140
Small-mouthed black bass	†137,000
	1,500
Sunfish	56,290
Yellow perch	†225,000
	235
Louisiana:	
Buffalo fish	*29,850,000
	†51,000,000
Crappie	530
Large-mouthed black bass	2,750
Sunfish	8,100
Maine:	
Atlantic salmon	†1,334,000
	180
Brook trout	†782,430
	142,800
Flounder	†922,777,000
Humpbacked salmon	†369,860
Lake trout	*50,000
Landlocked salmon	†187,230
	67,860
Large-mouthed black bass	240
Rainbow trout	†16,000
Small-mouthed black bass	†22,000
	385
Smelt	†300,000
Maryland:	
Brook trout	16,600
Chinook salmon	6,000
Lake herring	*1,000,000
Maryland—Continued.	
Large-mouthed black bass	4,460
Rainbow trout	*135,000
	35,175
Rock bass	260
Shad	†16,048,600
Sunfish	1,200
Yellow perch	†43,863,000
Massachusetts:	
Brook trout	*5,000
	181,520
Buffalo fish	250
Catfish	6,000
Cod	*208,224,000
	†232,131,000
Flounder	*198,268,000
	†925,247,000
Haddock	*75,960,000
	†290,820,000
Large-mouthed black bass	390
Mackerel	†1,980,000
Pike perch	†1,600,000
Pollock	†327,380,000
Rainbow trout	40,827
Sea bass	†32,000
Scup	†2,505,000
Small-mouthed black bass	†8,000
	890
Steelhead salmon	†20,000
Sunfish	400
Yellow perch	†200,000
	105
Michigan:	
Brook trout	†60,000
	153,500
Catfish	1,800
Crappie	625
Lake herring	*32,500,000
Lake trout	*36,000
	†24,973,000
	66,000
Large-mouthed black bass	9,285
Pike perch	*56,550,000
Rainbow trout	*50,000
	†52,000
	33,000
Rock bass	200
Small-mouthed black bass	†82,750
	23,267
Sunfish	1,625
Whitefish	*160,000
	†68,950,000
Yellow perch	600
Minnesota:	
Brook trout	98,700
Buffalo fish	61,506
Carp	3,483,945
Catfish	8,946,375
Crappie	12,577,125
Fresh-water drum	25,585
Lake trout	*1,200,000
	†1,700,000
	85,000
Large-mouthed black bass	177,825
Pike and pickerel	598,673
Pike perch	†150,000
Rainbow trout	†13,600
	47,200
Sunfish	11,728,971
Steelhead salmon	*50,000
White bass	14,460
Whitefish	†800,000
Yellow perch	1,209,725
Miscellaneous fishes	14,450

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Mississippi:	
Crappie	450
Large-mouthed black bass	†27,940
	174,000
Sunfish	71,650
Missouri:	
Catfish	200
Crappie	4,310
Large-mouthed black bass	46,656
Rainbow trout	*143,000
	311,822
Rock bass	1,218
Small-mouthed black bass	223
Sunfish	50,095
Yellow perch	*4,000,000
	†600,000
Montana:	
Black-spotted trout	*437,500
	†425,000
	442,000
Brook trout	431,575
Catfish	11,530
Chinook salmon	*100,000
Lake trout	*100,000
Large-mouthed black bass	750
Rainbow trout	*315,000
	†30,000
	415,500
Steelhead salmon	*72,000
Sunfish	115
Whitefish	*5,000,000
Nebraska:	
Brook trout	23,950
Large-mouthed black bass	625
Rainbow trout	10,000
Nevada: Rainbow trout	*100,000
New Hampshire:	
Brook trout	†478,120
	364,550
Catfish	600
Lake trout	†5,900
	24,450
Landlocked salmon	20,000
Pike perch	†1,000,000
Rainbow trout	18,880
Small-mouthed black bass	†9,500
New Jersey:	
Brook trout	900
Catfish	100
Lake trout	*25,000
Large-mouthed black bass	2,850
Rainbow trout	1,350
Yellow perch	90
New Mexico:	
Brook trout	109,500
Carp	60
Catfish	2,125
Crappie	2,430
Large-mouthed black bass	300
Rainbow trout	*75,000
	3,000
Rock bass	400
Sunfish	815
Yellow perch	100
New York:	
Black-spotted trout	*10,000
Brook trout	†479,500
	47,100
Catfish	1,550
Crappie	275
Lake herring	*72,890,000
	47,400,000
Lake trout	*1,010,000
	†756,000
Landlocked salmon	*10,000
	4,800
New York—Continued.	
Large-mouthed black bass	4,365
Pike perch	†400,000
Rainbow trout	*10,000
	†157,500
	21,000
Rock bass	†300
	1,000
Small-mouthed black bass	175
Steelhead salmon	*60,000
Sunfish	220
Whitefish	*34,950,000
	†32,000,000
Yellow perch	*400,000
	†11,500,000
	235
North Carolina:	
Brook trout	†90,000
	85,500
Crappie	45
Glut herring	†82,600,000
Large-mouthed black bass	†36,400
	31,379
Rainbow trout	500,910
Rock bass	3,000
Shad	†27,459,000
Small-mouthed black bass	1,500
Striped bass	†25,530,000
Sunfish	14,990
Warmouth bass	155
North Dakota:	
Catfish	6,200
Crappie	380
Large-mouthed black bass	1,390
Rainbow trout	1,500
Sunfish	5,360
Yellow perch	700
Ohio:	
Brook trout	530
Buffalo fish	4,320
Carp	†82,050,000
Catfish	5,400
Crappie	250
Large-mouthed black bass	5,418
Pike perch	†42,500,000
Rainbow trout	*21,600
	2,700
Rock bass	4,000
Small-mouthed black bass	†57,000
	16,050
Steelhead salmon	*25,000
Sunfish	9,550
Whitefish	†204,600,000
Yellow perch	*25,000,000
	†16,000,000
	575
Oklahoma:	
Catfish	2,050
Crappie	2,810
Large-mouthed black bass	8,740
Rainbow trout	95,900
Rock bass	800
Sunfish	4,165
Yellow perch	455
Oregon:	
Black-spotted trout	13,000
Brook trout	†50,000
	1,000
Chinook salmon	*1,300,000
	†1,311,550
	11,412,650
Grayling	†25,000
Rainbow trout	57,963
Silver salmon	110,000
Steelhead salmon	*20,000
	1,662,420

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Pennsylvania:	
Brook trout	550,845
Carp	300
Catfish	13,700
Crappie	300
Lake herring	*114,300,000
Lake trout	*50,000
Large-mouthed black bass	15,609
Pike perch	*4,200,000
	†500,000
Rainbow trout	*50,000
	284,450
Rock bass	†700
	1,060
Steelhead salmon	*50,000
Sunfish	11,035
Whitefish	*32,340,000
Yellow perch	†3,500,000
	830
Rhode Island: Small-mouthed black bass	†2,000
South Carolina:	
Brook trout	†5,000
	9,000
Catfish	190
Crappie	200
Large-mouthed black bass	†103,145
	118,100
Rainbow trout	29,000
Sunfish	8,310
Warmouth bass	500
South Dakota:	
Brook trout	249,350
Catfish	550
Crappie	560
Large-mouthed black bass	4,950
Loch Leven trout	27,000
Rainbow trout	165,500
Sunfish	1,150
Yellow perch	100
Tennessee:	
Brook trout	†3,000
	1,500
Catfish	1,600
Crappie	1,700
Large-mouthed black bass	10,395
Rainbow trout	*50,000
	101,800
Rock bass	9,075
Small-mouthed black bass	5,655
Sunfish	13,800
Yellow perch	80
Texas:	
Catfish	37,500
Crappie	565
Large-mouthed black bass	576,520
Rock bass	845
Sunfish	85,050
Utah:	
Brook trout	*250,000
	83,260
Lake trout	*100,000
Rainbow trout	553,500
Vermont:	
Brook trout	†590,000
	60,000
Lake trout	*25,000
	†149,465
	7,940
Landlocked salmon	3,125
Pike perch	†5,237,500
Rainbow trout	9,000
Small-mouthed black bass	524
Vermont—Continued.	
Steelhead salmon	*50,000
Yellow perch	†5,000,000
Virginia:	
Brook trout	65,200
Catfish	904
Crappie	2,165
Large-mouthed black bass	†17,764
	66,500
Rainbow trout	267,700
Rock bass	13,435
Shad	†19,953,600
Small-mouthed black bass	†10,000
	375
Sunfish	38,600
Yellow perch	†124,239,200
Washington:	
Black-spotted trout	10,000
Brook trout	120,400
Chinook salmon	40,255,010
Chum salmon	†1,540,000
	14,027,620
Grayling	†225,000
Humpbacked salmon	909,400
Rainbow trout	12,000
Silver salmon	†600,000
	10,964,940
Sockeye salmon	†4,200,000
	7,702,365
Steelhead salmon	*123,000
	365,800
West Virginia:	
Brook trout	148,430
Catfish	625
Crappie	100
Large-mouthed black bass	†9,000
	6,445
Rainbow trout	364,150
Rock bass	1,200
Small-mouthed black bass	†26,000
Sunfish	3,075
Yellow perch	†1,500,000
Wisconsin:	
Brook trout	760,240
Buffalo fish	1,185,355
Carp	7,421,240
Catfish	26,488,666
Crappie	14,706,310
Fresh-water drum	3,280
Lake trout	†1,775,000
Large-mouthed black bass	95,880
Pike and pickerel	62,932
Pike perch	†450,000
	34,050
Rainbow trout	†25,600
	152,933
Rock bass	1,240
Sunfish	19,494,490
White bass	13,300
Whitefish	*21,600,000
Yellow perch	347,170
Miscellaneous fishes	4,030,460
Wyoming:	
Black-spotted trout	*250,000
	†68,400
	106,500
Brook trout	462,750
Catfish	3,000
Lake trout	*100,000
Large-mouthed black bass	3,000
Loch Leven trout	9,000
Rainbow trout	*446,240
	†80,000
	585,500
Rock bass	1,000

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

FOREIGN COUNTRIES.

Country and species.	Number.
Canada:	
Black-spotted trout [1]	* 200,000
Landlocked salmon [1]	* 100,000
Rainbow trout [1]	* 450,000
Whitefish	* 61,192,000
Czechoslovakia: Rainbow trout	* 100,000
Switzerland:	
Lake trout	* 50,000
Rainbow trout	* 50,000
Total	* 62,142,000

[1] In exchange for an equal number of Atlantic-salmon eggs.

ASSIGNMENTS TO STATE AND TERRITORIAL FISH COMMISSIONS.

Those States and territory in which part of the output distributed was assigned to the State and Territorial Fish Commissions as applicants are given in the following table, showing the number and species of fish and fish eggs delivered to each such commission.

Assignments of fish and fish eggs to State and Territorial Fish Commissions, fiscal year 1922.

[Asterisk (*) denotes eggs; dagger (†), fry; all others are fingerlings.]

State and species.	Number.
Hawaii: Rainbow trout	* 51,000
Idaho: Whitefish	* 1,000,000
Illinois:	
Black bass	227
Carp	100
Catfish	15,165
Crappie	4,800
Drum	10
Pike	50
Rock bass	40
Sunfish	30,800
Yellow perch	25
Indiana: Pike perch	* 13,800,000
Iowa:	
Brook trout	41,500
Lake trout	* 50,000
Pike perch	* 5,100,000
Rainbow trout	* 206,000
	1,500
Kansas: Yellow perch	* 5,000,000
Maine: Lake trout	* 50,000
Maryland:	
Cisco	* 1,000,000
Chinook salmon	5,000
Rainbow trout	* 135,000
Massachusetts:	
Buffalo fish	250
Catfish	4,000
Michigan:	
Cisco	* 32,500,000
Lake trout	600,000
Rainbow trout	* 50,000
Pike perch	* 56,500,000
Albino brook trout	10,000
Minnesota:	
Black bass	6,395
Crappie	3,150
Lake trout	* 1,200,000
Steelhead salmon	* 50,000
Sunfish	39,050
Yellow perch	120
Missouri:	
Rainbow trout	* 143,000
	36,280
Yellow perch	* 4,000,000
Montana:	
Black-spotted trout	* 587,500
Chinook salmon	* 100,000
Lake trout	* 100,000
Rainbow trout	* 215,000
Steelhead salmon	* 72,000
Whitefish	* 5,000,000
New Hampshire: Lake trout	14,000
New Jersey: Lake trout	* 25,000
New Mexico:	
Brook trout	36,000
Rainbow trout	* 75,000
New York:	
Cisco	* 16,050,000
Lake trout	* 1,000,000
Steelhead salmon	50,000
Whitefish	* 15,000,000
North Dakota:	
Black bass	930
Catfish	5,600
Crappie	280
Sunfish	4,380
Yellow perch	700
Oklahoma: Rainbow trout	113,500
Oregon:	
Chinook salmon	* 1,300,000
Grayling	† 25,000
Pennsylvania:	
Catfish	200
Cisco	*114,300,000
Lake trout	* 50,000
Pike perch	* 4,200,000
Steelhead salmon	* 50,000
Whitefish	* 32,340,000
Tennessee: Rainbow trout	* 50,000
	16,000
Utah:	
Brook trout	* 250,000
Lake trout	* 100,000
Vermont:	
Lake trout	* 25,000
	91,865
Rainbow trout	3,000
West Virginia: Rainbow trout	116,000
Wisconsin:	
Black bass	6,790
Catfish	1,920
Crappie	660
Sunfish	8,400
Yellow perch	2,975
Whitefish	* 21,000,000
Wyoming:	
Black-spotted trout	* 250,000
Brook trout	24,000
Lake trout	* 100,000
Rainbow trout	* 446,240
Total	* 333,570,740
	1,245,662
	† 25,000

DISTRIBUTION METHODS AND EQUIPMENT.

IMPROVEMENTS TO FISHERIES CAR NO. 9.

By making a slight change in the interior arrangement of fisheries car No. 9, one of the new steel cars, it has been possible to increase its carrying capacity from 140 to 156 cans. This has been brought about by fitting up a small dining room at one end of the can compartments, thereby permitting the utilization of the space in the center of the car for carrying fish. The new arrangement, besides resulting in economy for the bureau in that it allows a larger load of fish to be carried, is found more satisfactory than the old, as the table in its new position is made stationary and can be used by the messengers in writing up reports. Besides, it is so located that it permits of an unobstructed passageway through the car at all times.

USE OF GALVANIZED VESSELS IN TRANSPORTING LIVE FISH.

Because of a rather general belief among fish-culturists that galvanized vessels are not suitable for the transportation of living fishes, the bureau conducted a number of experiments with such vessels during the year. The following extract from the Fisheries Service Bulletin No. 83, for April 1, 1922 (pp. 3–4), briefly outlines the results:

On car No. 7 a galvanized-iron bucket 13½ inches high and 13½ inches in diameter (the ordinary type of garbage can) was used throughout the season without loss of fish. On one occasion black bass were transported in such a can from Dubuque, Iowa, to Baltimore, Md. From that point they were forwarded by special messenger on a 12-hour trip to the applicant, and the fish were delivered in excellent condition. Again, on a trip from La Crosse, Wis., to Mammoth Spring, Ark., some of the largest black bass intended for brood stock were carried in this can without loss. This vessel was treated in every respect, including the numbers of fish carried, in a manner similar to the general practice in transporting fish. Results were equally satisfactory in transporting all other species handled throughout the season. On car No. 8, 100 rock bass (No. 2 fingerlings) were moved from Marquette, Iowa, to Eaton, N. Mex. The fish were received on the car October 24 and reached their final destination November 2 without loss. On the same date and at the same place 30 yearling crappie were placed in a galvanized-iron bucket with 8 gallons of water and were delivered to an applicant at Trinidad, Colo., on November 2, with a loss of five fish on a trip of nearly eight days' duration.

The only precaution necessary in the use of galvanized vessels in transporting live fish is apparently their thorough cleaning prior to use. Galvanized vessels possess certain advantages over tinned vessels now in general use. They are practically immune from rust, their cost is considerably less, and it is the belief of many fish-culturists that the duller-surfaced material produced by galvanizing is preferable to a tinned surface, from the fact that it reflects less light, and thus provides more nearly normal surroundings for the fish.

Further experiments along this line have been conducted recently, the result in each case tending further to prove that galvanizing is not harmful to fish. The recent experiments involve such species as rainbow, brook, and lake trouts, and whitefish fry and fingerlings. The fish were in transit for periods ranging from 6½ to 35½ hours without change of water, and in each case they arrived at destination in good condition.

NEW METHOD OF SHIPPING LIVE FISH WITHOUT ICE OR ATTENDANT.

One of the problems that the bureau has recently been called upon to solve is the distribution of fish in increasing numbers without additional funds to meet the increased transportation charges. In view of the facts that passenger, freight, and express rates are now higher than at any period in our history, and that there is an insistent demand for economy in both Government and private business, it has seemed most opportune to undertake a new method of shipping live fish without ice and, in many instances, without the usual attendant. The possibilities in economy over the present method of shipping by messenger are readily apparent.

EXPERIMENTS WITH DIFFERENT CANS.

Experiments made with lard cans placed in loosely fitted bags of 10-ounce canvas with means for keeping the canvas moist tend to show that an even temperature can be maintained, and that when the margin between the air and water temperature is not too great the temperature of the water may be considerably reduced through evaporation. The underlying principle involved in the plan is the cooling effect of evaporation, and since heat greatly stimulates evaporation, the principle might be successfully applied, within certain reasonable limits, in almost direct ratio to the need.

The following table indicates the results of some experiments conducted along this line:

Experiments showing comparable results with different cans under varying conditions.

Day and hour.	Air temperature.	Water temperature (°F.).					Location of can.
		Standard 10-gallon can.	Lard can, wet sack.	Lard can without jacket.	Lard can, dry canvas jacket.	Lard can, wet canvas jacket.	
June 20:							
9.30 a. m.	79	48	48			48	In yard at bureau.
12.30 p. m.	90	70	62			62	
2.30 p. m.	92	77	68			68	
3.30 p. m.	80	78	70			70	
June 28:							
10 a. m.	84	81		81		81	Indoors; tops open.
12 noon.	87	81½		81½		80	
4 p. m.	89	81½		81½		78	
June 29:							
9.30 a. m.	79	56		56		56	In shade; tops open.
1.30 p. m.	87	68		68		66	
3.30 p. m.	84½	72		72		69½	
July 26:							
9.15 a. m.	84			80	80	80	In shade in yard at bureau.
1.15 p. m.	95			84	82	76	
4.15 p. m.	94			85½	82	75	
9 a. m.[1]	83			80	78	73	
July 27:							
9.30 a. m.	85			81	81	81	In sun in yard at bureau.
11.30 a. m.	113			86	84	80½	
1.30 p. m.[2]	111			89	88	81	
4.15 p. m.	101			92	89½	80½	

[1] Following morning; jacket still moist.

[2] Moistened jacket of cans.

It is not intended to convey the idea that special attendants will not be necessary in handling large shipments of fish or under particularly difficult conditions, but by taking a large number of cans to some central point and sending allotments of fish to the various applicants one man should be able to cover a given territory more expeditiously and economically than is possible under the present system. Reaching applicants residing at points off the main railroad lines usually involves extra expense, since the attendant, because of irregular train service, frequently has been obliged to remain over night at the point where the last delivery of fish was made.

The lard can and jacket complete costs less than $1.50. The jacket represents about 65 per cent of the total cost. In short-distance shipments, where express charges are not high, the cans may be returned for reuse. In cases where there would be excessive express charges the recipient of the fish may be requested to return the jackets only, by parcel post, a frank being furnished for the purpose.

PRACTICAL APPLICATIONS.

A specific instance of the results obtained by this method is illustrated by the following in connection with the distribution from the Orangeburg (S. C.) station in the fall of 1921. A messenger with 20 cans of black bass and bluegills left Orangeburg at 5.30 a. m. He supplied 17 applicants at 9 points, and returned to the station at 11 p. m. on the same date, the entire expense in connection therewith being $21.47. The method of procedure was from Orangeburg to Fayetteville (N. C.), where six applicants were supplied. From Fayetteville fish were forwarded in jacketed cans, in care of the train baggage-masters, to 11 applicants. Had the messenger delivered fish to each applicant in person 65½ hours would have been required, and the cost would have been practically doubled. The cost of distribution from the Orangeburg station during the fall of 1920 under the old method was $1.57 per can of fish distributed; the cost under the new method during 1921 was 90 cents per can.

From the Bullochville (Ga.) station 28 deliveries were made on four messenger trips. On one trip to Atlanta, Ga., 10 shipments of fish were made to points in Tennessee, Alabama, North Carolina, and Georgia. No complaints were received.

In the fall of 1920 a special shipment of Gambusia was sent by messenger from Edenton, N. C., to Washington, D. C., the cost of the trip being approximately $25. Practically the same number of Gambusia was shipped to Washington, D. C., in the fall of 1921 in two jacketed cans, the express charges being only $1.57.

At the Edenton (N. C.) station a reduction of approximately 50 per cent in the distribution costs was brought about during the fiscal year 1922 by generally adopting the new method. Messengers with fish for distribution were sent to the three important railroad centers—Greensboro, Raleigh, and New Bern, N. C.—and the consignments were forwarded to applicants from those points by express or in care of the train baggage-masters. No complaints came to hand of failure to receive fish or of fish received in poor condition. The following statement shows the actual costs of making

the distribution of sunfish from the Edenton (N. C.) station for the fiscal years 1921 and 1922:

Comparative costs per trip of distribution of sunfish from Edenton (N. C.) station, fiscal years 1921 and 1922.

Destination.	Number of applicants supplied.	Number of cans.	Number of fish.	Cost.
Old method (1920):				
Raleigh, N. C	6	12	1,800	$32.94
Catawba, N. C	5	13	1,910	32.00
Chapel Hill, N. C	8	16	2,519	20.14
Raleigh, N. C	8	17	2,350	30.84
Mount Gilead, N. C	4	8	1,200	36.40
Total, 1920	31	66	9,779	152.32
Average cost per thousand				15.57
New method (1921):				
Greensboro, N. C	21	21	2,650	24.19
Raleigh, N. C	22	22	2,125	17.49
New Bern, N. C	19	20	3,400	21.15
Total, 1921	62	63	8,175	62.53
Average cost per thousand				7.64

NEW EQUIPMENT FOR USE IN SHIPPING LIVE FISH.

In connection with the foregoing a number of new devices making for greater economy and efficiency have been developed during the year, and are discussed and illustrated in the following pages.

FISH-TRANSPORTATION PAIL.

This device, developed by E. C. Fearnow, superintendent of fish distribution, United States Bureau of Fisheries, was patented June 13, 1922 (see agreement and license below), and the drawing and descriptive text are taken from the United States Patent Office specification of letters patent No. 1419549. (See fig. 4, p. 94.)

AGREEMENT AND LICENSE.

Whereas Edgar C. Fearnow, a resident of Capitol Heights, in the county of Prince Georges and State of Maryland, has invented a container for transporting live fish and has filed on March 6, 1922, an application for United States letters patent thereon, serial No. 541500; and

Whereas the said Edgar C. Fearnow is desirous of granting, and the United States Government of receiving, rights in and to said invention and any patent granted thereon:

Now, therefore, in consideration of one dollar ($1) and other valuable considerations paid by the United States Government to the said Edgar C. Fearnow, the receipt of which is hereby acknowledged, the said Edgar C. Fearnow agrees to and does hereby grant to the United States Government, and to each and all of its component departments, a license to employ the device described and claimed in said application and in any patent granted upon or covering said invention to the full end of the term or terms thereof, and to make and use and to have made and to have used by others, all for United States governmental purposes only, any substance, material, or article embodying said invention.

And the said Edgar C. Fearnow covenants for himself, his legal representatives, and assigns, that he owns and controls the entire right, title, and interest in and to said invention, and application for patent, and that no representation has been made nor any instrument executed by him inconsistent herewith.

The United States retains, notwithstanding anything in this agreement, all rights which it has by virtue of the act of June 25, 1910, as amended by the act of July 1, 1918.

S. W. STRATTON,
Acting Secretary of Commerce for the United States.

Personally appeared before me Edgar C. Fearnow, known to me to be the person named in the foregoing agreement and license, who executed the same in my presence and acknowledged the execution of this instrument to be his free act and deed, on this 14th day of March, 1922.

E. W. LIBBEY, *Notary Public.*

The container consists of an outer receptacle *1*, made of any suitable size and material with a series of perforations or vents *2* somewhat below the upper edge for the purpose of admitting air into the interior in case something is set on top of the container.

The bottom compartment or tray *3* fits into the outer receptacle *1*, being held in place by the flanged edge *4*, which rests upon the shoulder *5* of the outer receptacle. The body *6* of the bottom tray *3* is pierced by a number of small apertures *7*, said body tapering from top to bottom more rapidly than the sides of the outer receptacle *1*, providing an air space *8* between the sides of the bottom tray *3* and the outer receptacle *1*. The bottom *9* of the tray *3* is shown dished downwardly somewhat and also perforated by several small holes *10* in the center.

The upper tray *11* also fits into the outer receptacle *1*, the lower edge *12* resting upon the shoulder *5* of the outer receptacle. The bottom *13* of the upper tray *11* is perforated with a series of small apertures *14* and may also have a large central hole *15* to permit inspection of the interior.

In use the receptacle *1* is partially filled with water of a predetermined temperature until the depth in the bottom tray *3* is sufficient to submerge the bodies of the fish. An absorbent jacket *16* may then be drawn over the container and its inner flap *17* folded inwardly and down over the edge of the outer receptacle *1*. Then the upper tray *11* is placed within the receptacle *1* and the inner flap *17* of the absorbent jacket *16* is thus held in position between the outer receptacle *1* and the upper tray *11*, the width of the flap *17* being sufficient to permit it to extend below the bottom of the upper tray. The jacket *16* may then be moistened and is maintained in that state by the wicklike action of the flap *17* and the splashing of water from the lower trap *3* onto the projecting edge of the flap *17*. The evaporation of moisture in the jacket *16* draws heat from the interior of the container, thereby keeping the water sufficiently cool to permit the fish to live.

The outer flap *18* of the absorbent jacket *16* is shown split to permit it to be drawn over the top of the container and fastened by means of a drawstring *21* passing through the eyelets *19* without interfering with the bail *20*.

Automatic aeration is accomplished by the invention in the folling manner: The fish in the bottom tray *3* are compelled to remain almost at the surface of the water where the greatest amount of oxygen is present. When the container is in motion, the swaying and jolting thereof will cause the water in the outer receptacle to move from side to side. Since water is incompressible and the body of water in the lower part of the outer receptacle *1* entirely fills the

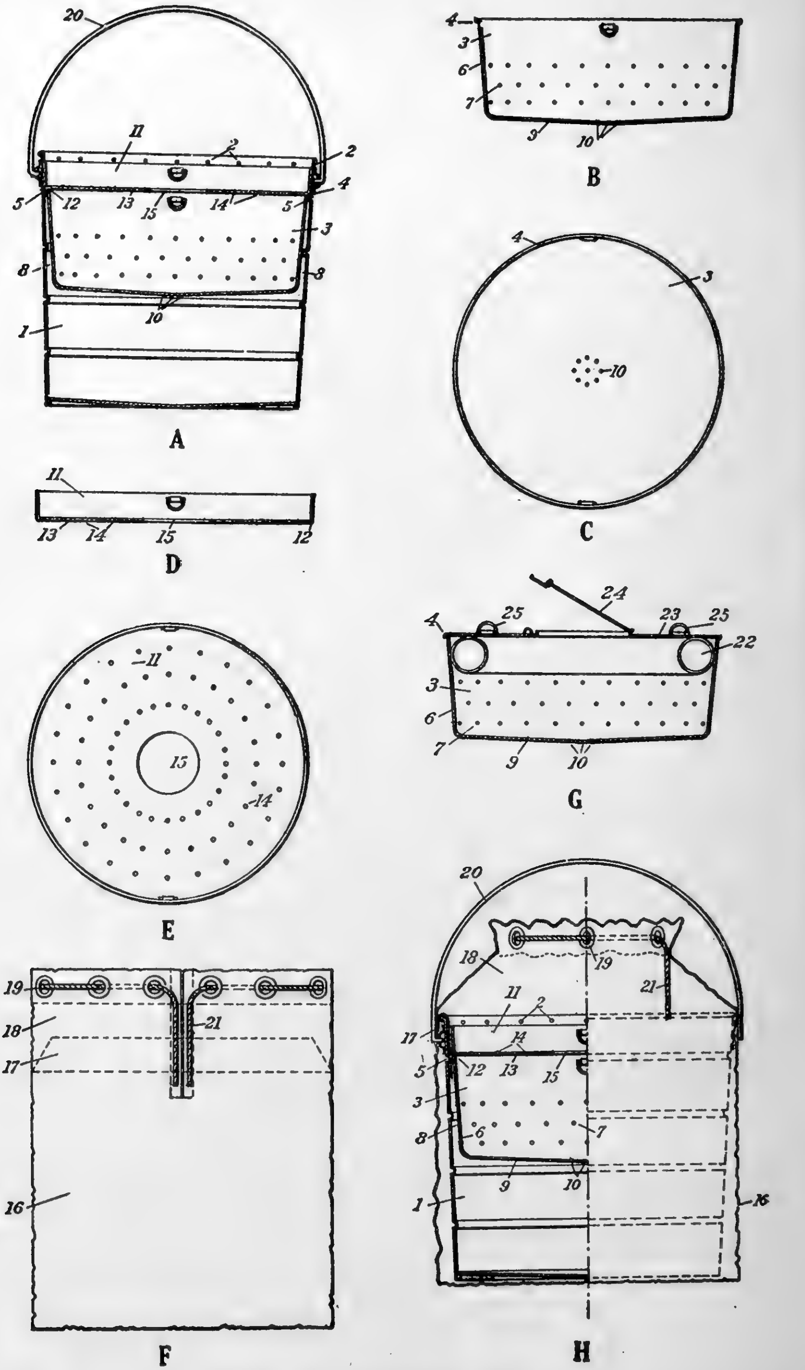

FIG. 4.—The Fearnow self-aerating fish transportation pail with canvas jacket. *A*, Vertical section of container; *B*, vertical section of lower tray; *C*, plan view of lower tray; *D*, vertical section of top tray; *E*, plan view of top tray; *F*, elevation of jacket; *G*, vertical section of a tray that may replace other trays in case container is used as a minnow or bait pail; *H*, side elevation, partly in section, of container with absorbent jacket in position.

space between the bottom and sides of the outer receptacle *1* and the bottom of lower tray *3*, this body of water can move only by virtue of the air space *8* between the sides of the outer receptacle *1* and lower tray *3*, with the result that a portion of the water will be forced up into the air space *8* with considerable violence and pressure by the mass movement of the body of water in the lower part of the outer receptacle and will pass in small jets from the space *8* into the lower tray *3*, not only through the perforations *7* in its sides, which are below the normal surface of the water, but also through the perforations *7* which are above the surface of the water, falling therefrom through the air into the lower tray *3* and becoming aerated by its passage through the air.

The amount of water thus forced into the lower tray *3*, will, because of the pressure to which it is subjected, be somewhat greater than the quantity which will flow out by its own weight through the limited number of perforations *10* below the surface, with a result that the level of water in the lower tray will be raised somewhat above the level of the water in the outer receptacle until a point is reached where the area of the perforations submerged by the water within the lower tray *3* is sufficient to compensate for this forced injection. In this way a higher level of water is maintained within the lower tray *3*, which affords the fish greater freedom of action while the container is in motion.

When the container is stationary, the water level within the lower tray *3* immediately returns to its normal level to be determined by the character of fish to be shipped. For example, in shipping large fish as distinguished from fry, the water should be of sufficient depth to permit the fish to swim about with their dorsal fins exposed above the surface. The fish then assist in the aeration of the water.

When the supply of oxygen in the water becomes depleted, the fish begin to feel discomfort, which manifests itself in increased activity on their part and results in the splashing about of the water because of its extreme shallowness.

The upper tray *11* acts as a cover and baffle plate whenever the motion of the container is sufficient to cause the water to splash against it. The perforations *14* in the bottom of the upper tray *11* are of such dimensions that the water can not pass through in sufficient volume or with sufficient force to slop over, but will percolate back into the bottom tray *3*, becoming aerated in the process.

The upper tray *11* also serves as a receptacle for supporting ice when considered necessary; as, for example, when shipping cold-water fish, such as trout, in extremely hot weather. The perforations *14* permit the ice water to drip into the bottom tray *3*, carrying with it a large supply of oxygen. Under such circumstances the outer flap *18* of the absorbent jacket *16* is drawn over the ice and retained in position by fastening means, such as drawstrings *21*.

The bottom *9* of the tray *3* is shown slightly dished and perforated at its lowest point, the center *10*. The excrement of the fish settles to the bottom of the tray *3* and passes through perforations at the center *10* into the lower part of the container where it settles and remains on the bottom because of the comparative stillness of the water in that part.

If desired, the bottom tray *3* may be provided near its upper edge with a buoyant member *22*, so that it will float and may be towed behind a boat during the collection of the fish to be transported. Such an arrangement is shown by *G* (fig. 4).

G also shows a desirable construction of bottom tray *3* when the container is to be used as a minnow bucket or fisherman's live-bait pail. Float *22* is shown secured to the inside of bottom tray *3* near its upper edge. The cover *23*, having a hinged lid *24*, may be added. This device may be secured to a boat or other convenient object by means of a cord attached to rings *25*. Furthermore, it may be placed within the outer receptacle *1* and will then perform the functions of the simple bottom tray *3* heretofore described, in addition to its function as a floating pail.

This pail as adopted by the bureau, although only 12 inches high and 13½ inches in diameter, carries as many fish as are commonly placed in the regulation 10-gallon milk can. As it is possible to place five of these pails in the space occupied by three milk cans, the carrying capacity of the cars has been increased 66⅔ per cent. The device is especially useful in shipping fish for considerable distances without an attendant. It also affords a practical means of transporting fish to the headwaters of streams that have heretofore been neglected on account of their inaccessibility.

AUTOMATIC SIPHON AND IMPROVED TRAY FOR ICE.

The automatic siphon for removing pollution from fish cans and maintaining a water level, thereby facilitating the changing of water on fish, and the improved type of tray for ice were designed by E. C. Fearnow and patented under the act of March 3, 1883 (22 Stat. L. 625). (See fig. 5.) The object of the invention is, primarily, to provide a simple and efficient means for removing sediment and pollution from the container, and, secondarily, to provide means for maintaining the water level at a substantially fixed point. These results are accomplished by combining with a tank or a container of any desired type a siphon so arranged that by tilting the container, or by the addition of water to the container, the siphon may be submerged and caused to operate to remove sediment and polluting matter and to reduce the quantity of water within the container to a predetermined amount.

The device illustrated by *A* (fig. 5) consists of the container *1*, which, in this instance, resembles an ordinary 10-gallon milk can. This shape has been extensively used by hatcheries for the shipment of live fish, because water is not likely to slop out of it unless it is filled too full. The bottom *2* of the container is shown dished downwardly somewhat and is connected with the body of the container a short distance above the lower edge, as at *3*, so that a space will be preserved between the bottom and any surface upon which the container may be placed. Within the container is a siphon *4*, shown as a pipe, principally in the shape of an inverted **U**. The top *5* of the siphon is located at the highest point to which it is desired to permit the water within the container to rise. The intake legs *6* of the siphon passes through the bottom of the container and connects with

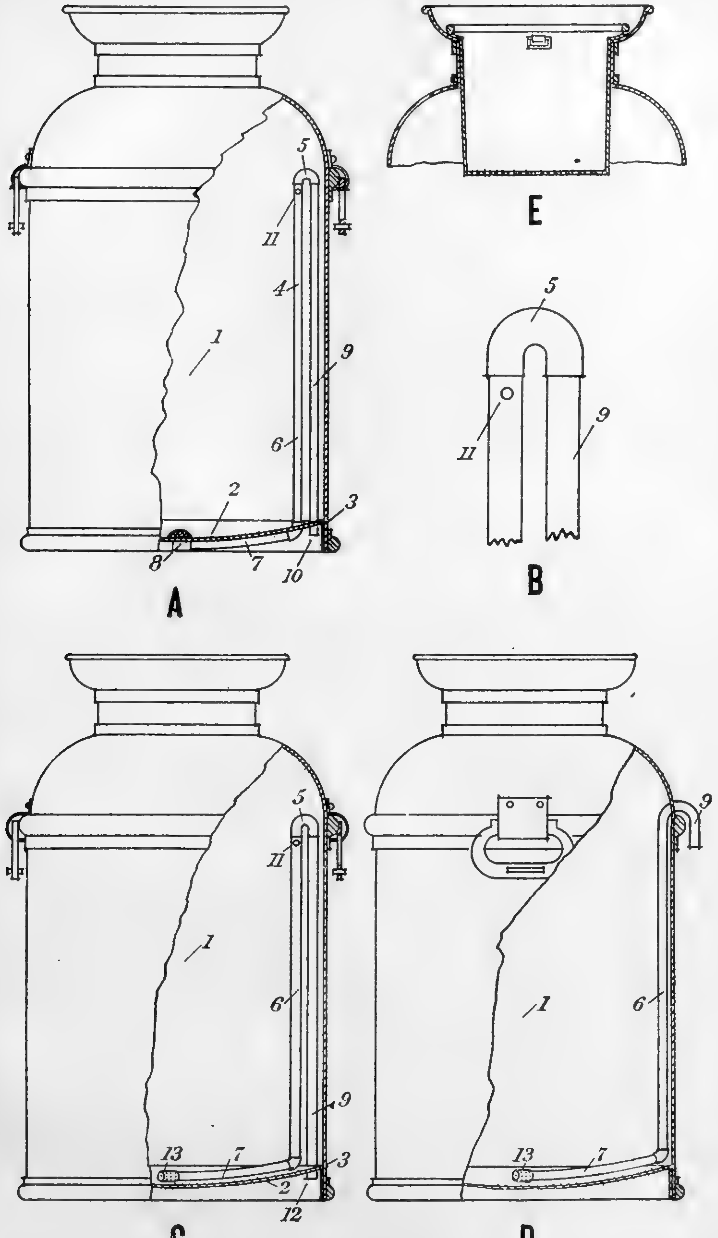

FIG. 5.—Automatic siphon used with ordinary fish transportation can for removal of sediment and surplus water, and improved tray for ice. *A*, Perspective view, partly broken away and in section, of a container equipped with the siphon; *B*, fragmentary vertical cross section of the siphon; *C* and *D*, perspective views, partly in section, of containers with modified forms of the siphon; *E*, vertical cross section of the upper part of a container with an improved type of tray for holding ice.

a pipe *7*, which runs along the underside of the bottom to its center *8*, where it connects with an aperture in the bottom *2*. A discharge leg *9* is shown passing through the bottom *2* to the container *10*, terminating in the space beneath the bottom of the container already referred to. At the point in the container at which it is desired to establish the normal water level one or more small holes *11* are drilled through the intake leg *6* of the siphon.

In use the container *1* is filled with water to the desired level, which corresponds with the small holes *11* in the intake leg *6* of the siphon. Under these conditions the siphon will remain inoperative and the water level constant. If the water level rises, however, because of the melting of ice that may be packed in the neck of the container, or for any other cause, so that the top *5* of the siphon becomes submerged, the siphon will automatically function and will draw water through the opening *8* in the bottom of the container and discharge it through the discharge leg *9* of the siphon. This action will continue until the water level within the container falls sufficiently to uncover the small openings *11* in the intake leg *6* of the siphon, whereupon the air that will pass into the siphon through the holes *11* will immediately stop its action. This arrangement provides a very strong suction at the intake end and will be found sufficient to draw off the greater part of the pollution that has settled at the bottom of the container.

The siphon may be caused to function regardless of the water level whenever it is desired to remove polluting matter by simply tilting the container so that the siphon is entirely submerged and tilting it back again when the desired result has been accomplished, after which water may be added to reestablish the desired normal level. The siphon arrangement will also make it impossible for the container to be filled too full, since the siphon will function as soon as its top *5* becomes submerged and will automatically reduce the water level to the desired normal.

A modification of the arrangement of the siphon of *A* (fig. 5) is shown in *C* (fig. 5), in which the entire siphon with the exception of the end *12* of the discharge leg *9* is located within the container, the extension *7* of the intake leg *6* being shown positioned within the container. This extension *7* may be made of rubber or other flexible material, so that it may be moved or may fall by gravity to the lowermost part of the container or that portion of the container from which it is desired to remove sediment. The intake end of this siphon may be covered with a strainer *13* if desired to prevent small fish or fish eggs from being siphoned out.

A further modification is shown by *D* (fig. 5). In this instance the siphon is not perforated at the desired water level, the small openings *11* being omitted. The discharge leg *9* of the siphon instead of terminating below the bottom of the container passes through the body of the container, terminating on the outside of the container at a point that corresponds with the desired level of the water within the container.

A covenient and improved form of receptacle for ice is illustrated by *E* (fig. 5), wherein a simple perforated pan is shown securely and conveniently mounted in the upper end of an ordinary can. The shape, of course, may be modified to adapt it to any type of container.

CANVAS JACKET FOR 10-GALLON CAN.

The canvas jacket, designed by E. C. Fearnow and illustrated in Figure 6, is found especially desirable when making shipments of fish to distant points during warm weather.

AERATING DEVICE.

This new aerating device for use in transporting live fish (fig. 7) was designed by M. A. Mason, engineer at the Cape Vincent (N. Y.) station. It consists of a hollow cylinder made of galvanized sheet iron 18 inches high by 6 inches in diameter. In the bottom are 28 one-half inch perforations from which fish are excluded by wire mesh fastened to the inside surface. At the top is a handle and a vent in the form of a $\frac{1}{2}$-inch brass pipe extending upward $1\frac{3}{4}$ inches.

In use the cylinder is inserted in the can of fish with the vent open and allowed to fill with water. The vent is then closed by the thumb of the operator and the cylinder withdrawn to a height several inches above the water level of the can. By opening the vent the water in the cylinder falls back into the can through the perforations, much broken up, carrying the needed oxygen with it.

Some of the advantages claimed for this device are that it removes for aeration water from near the bottom of the can, whereas the dipper in ordinary use takes mostly surface water. A larger amount of water is aerated at one operation than is possible with the dipper, and there is less chance of injury to the fish.

COST OF DISTRIBUTION.

During the fiscal year 1922 the bureau honored 10,376 applications for fish as compared with approximately 10,000 in the fiscal year 1921. By the use of improved methods and the exercise of the most rigid economy the distribution cost was slightly lowered. The following table gives comparative figures concerning cost of distribution for the fiscal years 1921 and 1922.

Fiscal year.	Number miles traveled.		Number applications honored.	Cost of distribution.
	Cars.	Messengers.		
1921	85,060	385,988	10,000	$69,600.00
1922	77,128	306,215	10,376	62,428.96

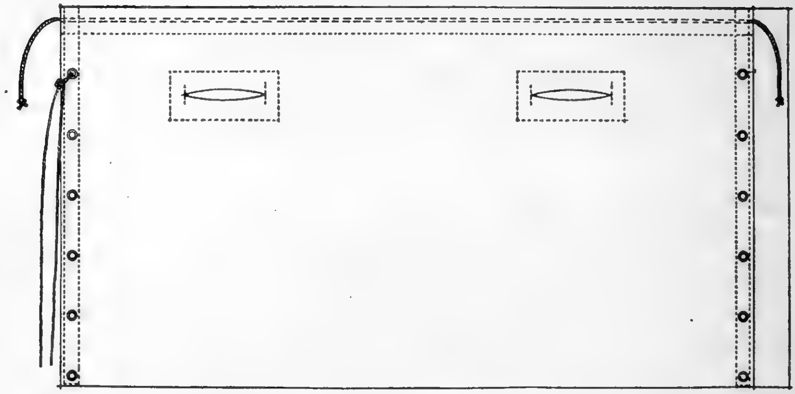

FIG. 6.—Canvas jacket for a 10-gallon fish transportation can for the purpose of maintaining temperature.

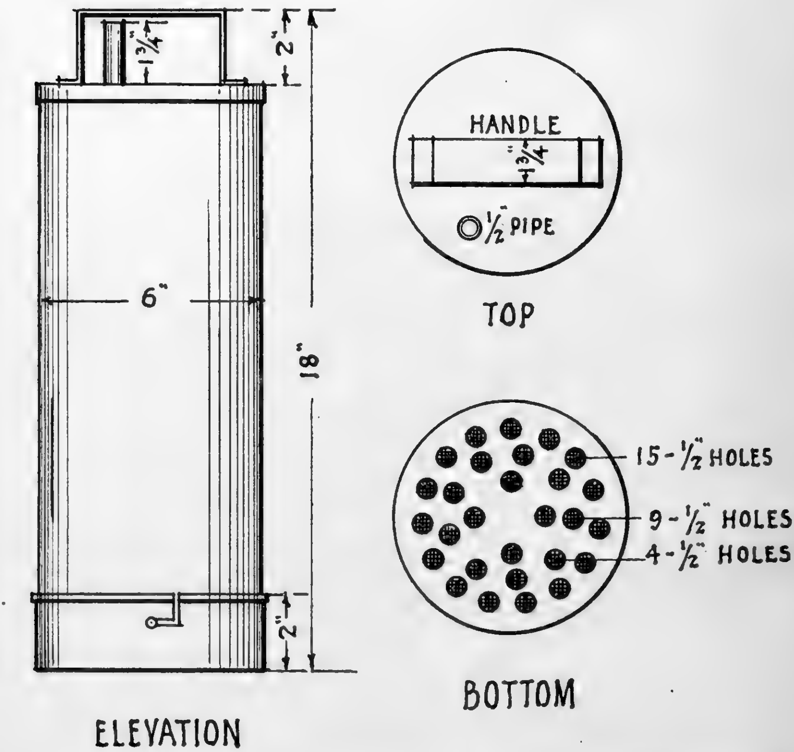

FIG. 7.—Aerating device to be used for removing water from fish-transportation can and breaking it into a fine spray.

STOCKING INTERIOR WATERS OF THE UNITED STATES.

By E. C. Fearnow, *Superintendent of Fish Distribution, U. S. Bureau of Fisheries.*

SPECIES DISTRIBUTED.

The cultivation of the fishes of the interior is an important feature of the bureau's work. The stocking of inland waters, public and private, is yearly becoming more generally appreciated, and a desire to actively cooperate in this work has been manifested throughout the country by persons interested in fishing as a business or for pleasure. Among the fishes most extensively propagated for this purpose are brook, rainbow, and black-spotted trouts, large-mouthed and small-mouthed black basses, rock bass, sunfish, crappie, and catfish. Various other species are also handled to a limited extent.

There are certain regions particularly well adapted as natural breeding grounds for such species as black bass, crappie, and bream, as for example, the State of Florida and the southern part of the State of Louisiana. It has not been found necessary to establish hatcheries in those States, since their supply of fish can best be increased by affording protection to the native species during their spawning seasons.

SPECIES LIMITED IN ASSIGNMENT.

SPINY-RAYED FISHES UNSUITED FOR TROUT AND SALMON WATERS.

The bureau adopted the policy some years ago of refusing all applications for black bass and allied species to stock waters of the Pacific States and Alaska now preeminent for their trout and salmon fisheries. This course was determined upon after a thorough canvass of the views of those most conversant with the situation and was indorsed by the officials of the States concerned. Although some waters of that section are not suited to trout or salmon, the few instances that may be cited do not impair the force of the bureau's contention for the exclusion of the species mentioned. There can be no denial of the fact that bass, sunfish, pike, and similar predacious fishes are antagonistic to trout and young salmon, and the bureau's experience has demonstrated the impracticability of confining the predatory species to specific waters where such are located in proximity to trout and salmon streams or lakes.

CARP CONSIDERED UNDESIRABLE BY MANY STATES.

As carp are considered undesirable by many of the State fisheries authorities, the bureau does not entertain applications for this species unless the requests bear the indorsement of the proper officials of the States in which the fish are to be planted. Even with this indorsement carp are not assigned for waters suited for the more desirable species.

ORNAMENTAL FISHES NOT DISTRIBUTED.

The bureau has no appropriation for the propagation of ornamental fishes nor has it any literature on goldfish breeding. Persons who desire information on this subject are advised to consult the standard goldfish works, which may be had at the public libraries. Ornamental fishes may be purchased from dealers in aquarium specialties.

RESCUE WORK.

For many years the bureau has been doing an important work of conservation by rescuing large numbers of native fishes from the temporary ponds and pools formed by the annual flooding of the Mississippi River and several of its tributaries. Over 99 per cent of the fish so rescued are returned to the parent streams and less than 1 per cent used for restocking depleted waters in the various States. Remarkable results have been attained in stocking small ponds on farms, and numerous cases are on record where ponds and lakes that contained no fish prior to their introduction by the bureau are now yielding a bountiful supply. Hundreds of favorable reports are annually received regarding this phase of the bureau's work.

DANGERS FROM OVERSTOCKING.

Overstocking is responsible in some instances for the small size fish attain. Applicants often request the introduction of new stock to correct this condition, whereas the remedy lies in reducing the number of fish to a point where the food supply will be sufficient to permit them to attain their maximum growth. By using in fish culture the same judgment that is exercised in stock raising the size of fish may be considerably increased and much better results obtained. A given area of ground will furnish forage for just so many cattle, and when more are added it means less food per capita. The same rule applies to fish, and no more should be placed in a body of water than the natural food supply will maintain. Young bass, crappie, and sunfish require natural food, and it is for this reason that any surplus fish should be removed to other waters in which a supply of suitable food is available.

METHODS OF INCREASING FISH SUPPLY.

Well-stocked streams and lakes add to the food supply of the country and also provide recreation for a large number of persons. As a recreation fishing is more generally engaged in than hunting, since the open season occurs during the vacation period. Good fishing often attracts attention to desirable sections that might otherwise be overlooked.

The supply of fish in a given body of water should be maintained in so far as possible by the natural reproduction of the original stock and its progeny. If, however, intensive fishing is carried on, it may be advisable to make additional plants of fish. There is danger in introducing new species, especially the more voracious kinds, where desirable species are established. The competition for food may result disastrously for the native species without giving

FIG. 8.—Removing rescued fish from seines to tubs.

FIG. 9.—Holding fish in transportation cans in streams when necessary to delay planting. Ends of cans covered with mosquito bar.

anything in return. The supply of fish in streams may be increased also by the closing of small feeder branches that are suitable for small fish and by the temporary closing of main streams in rotation.

POLLUTION OF STREAMS.

The following information on the pollution of streams, adapted from the report of the New York Conservation Commission for 1922, will enable those interested in stocking public waters to decide whether the streams in which they are interested are polluted to the extent that fish could not survive therein:

Pollution of a stream by sewage and other organic wastes may injure fish by removal of gaseous oxygen dissolved in water. This dissolved oxygen is as necessary to fish as is oxygen of the air to the ordinary air-breathing animal; without it the fish suffocate.

Certain common and easily recognized water plants and animals show accurately the dissolved oxygen content of the water and can be considered as indicators of the degree of pollution of a stream.

Water in a state of chemical purity does not exist in nature. Water flowing in any stream carries in solution certain salts, gases, and other compounds and frequently various matter in suspension. Only by the presence of these materials can aquatic life exist.

Pollution may actually kill fish at some stages of development and not at others. It may be harmful to some species and not to others, and it may have effects in any degree of gravity. It may affect a small area or many miles in the length of a stream. Intensity of pollution, extent of the affected area, and the habits of the fish normal to the stream must all be considered.

Fish themselves are not always the best indicators of the condition of a stream. Failure to catch fish does not prove that a condition of serious pollution exists. Absence, real or apparent, may be explained by overfishing, invisibility, or failure to take the hook, or the fish may have gone elsewhere on their own affairs and not because of pollution. The small plants and animals present, which either can not move at all or can not move far, show the average stream condition better than do the fish.

Plants growing in clean water are markedly green and frequently of more highly organized types than those in polluted sections, and animal life tends to be more active and highly organized. Typical forms of animals and plants that will not inhabit polluted waters are shown in the following list:

Dobson or "Helgramite" (*Corydalis cornuta*, Linn). Larva. Three to four inches long. Under or around stones in swift water.

Stonefly (*Perla sp.*) Nymph. Under and around stones in swift water; very flat body with two "tails."

Caddis worm (*Hydropsyche sp.*) Larva of the caddis fly. Several species with various habits and forms; in swift waters mostly; under stones in loosely constructed pebble and webbing cases; attached to stones on the lee side of the current in compact stone cases, or in a funnel-like strainer of webbing with a retreat.

May fly (*Heptogenia sp.*) Nymph. Under stones in swift water; very flat body, smaller usually than stonefly; three "tails."

Dragonfly (*Anax junius*, Dru). Nymph. Extensible "lower jaw;" darts forward by expelling water from behind; found in dense growths of green aquatic plants in still water. Damselfly nymphs are similar, but have three long featherlike "tails."

Water penny (*Psephenus lecontii*, Lec.) Larva of a beetle. Common in swift water, clinging closely to underside of stones, occasionally at top or sides.

Fresh-water shrimp or "scud" (*Hyalella sp.*) Weedy portions of the stream; rapid swimmers; tail foremost.

Water net (*Hydrodictyon reticulatum* (L) Lagerh). A green alga of the pond areas of streams. When spread, it resembles a fine meshed veil; a remarkable oxygenator.

Water moss (*Hypnum riparium*). Attached to stones or gravel in swift streams.

Some species of plants and animals are of little value as indicators of pollution, because they are found in both clean and polluted waters. Snails, black-fly larvæ, water boatmen, and similar forms have a wide range and therefore are not good guides to water condition, except to the scientist who can distinguish the different species.

Indicators of pollution may be summed up thus:

Water molds and scums, particularly if of colors other than green, indicate decreasing oxygen—conditions are not favorable and may be worse downstream.

Tubifex (a small, slender, red earthworm) marks approximately the limit of fish life.

Rat-tail maggots, if abundant over the whole bed of the stream, are an almost certain indication of prohibited pollution.

Bloodworms indicate recovery and conversion of wastes into fish food.

Green plants, mosses, silks, and nets usually indicate good and improving conditions.

METHOD OF DISTRIBUTION.

In making distribution of fish consideration is first given to the waters from which the fish or fish eggs were collected, after which shipments are then made to suitable public or private waters upon applications previously submitted. Blanks on which formal requests for fish may be made are furnished by the bureau. These blanks call for a complete description of the waters to be stocked, and from this information are determined the species of fish that is suitable and the number that can be apportioned to the water area in question.

The bureau finds it impracticable to investigate the condition of all streams to determine their suitability for particular species of fish, although such a study would be highly desirable, as it would afford a basis for intelligent assignments. Since this is not practicable at present and the bureau is required to rely on information furnished by applicants, it is decidedly important that such information be as accurate and complete as possible.

Applicants are notified immediately upon receipt of their requests concerning the species assigned and the approximate date of delivery and are given full directions for receiving and caring for the fish. Before shipment is made a second notice is given, usually by telegram, stating the exact time of arrival of the fish at the railroad station. The fish are delivered at the station without expense to the applicants. In the event that it becomes necessary to delay shipment the applicant is notified accordingly.

The bureau frequently receives requests from applicants for the loan of cans to transport fish from the railroad station to the waters where they are to be planted. As many applicants fail to understand why such requests can not be granted the following explanation is given:

Live fish are usually forwarded by the bureau in carload lots to central points, the cars being specially equipped for this purpose. Detached messengers, however, leave the cars at predetermined points with shipments of fish for applicants who live off the main lines. These messengers travel in baggage cars of regular passenger trains, and many deliveries are necessarily made while the train makes its customary stops. The messenger often has as many as 15 and 20 deliveries to make before returning to the car and must promptly return his full equipment of cans in order to make other shipments in accordance with a prearranged schedule. As the cans are part of the car's equipment, it is obvious that were they loaned to applicants it would necessitate a suspension of distribution work until they were returned.

It should be borne in mind that while some of the State fish commissions, due to the proximity of their hatcheries to the waters where the fish are to be planted, are able to lend cans to applicants, such a course on the part of the bureau would seriously cripple its distribution work, since its equipment is required to make distributions from hatcheries located in different States.

Applicants are urged, therefore, to provide themselves with receptacles suited for carrying fish to the headwaters of streams, such receptacles to be in readiness at the railroad station as specified in the notice which is sent by the bureau's agent in advance of the shipment. They should be uncovered and empty on the platform where the car of this bureau or baggage car is expected to stop, for the fish must be transferred to the vessels quickly without delaying the train beyond the time it ordinarily stops. If no receptacles have been provided, the fish will not be delivered nor will they be delivered, even though receptacles are in readiness, unless the applicant or his representative is on hand to take care of them and sign the required receipt. Under no circumstances, therefore, will the bureau loan its distribution equipment to applicants, and unless due provisions shall have been made to receive and properly care for the fish they will not be taken from the train.

SIZE OF ALLOTMENTS.

In making allotments on applications the following items are taken into consideration: The area of water to be stocked as stated in the application, size and number of fish available for distribution, and distance the fish have to be transported. The bureau does not attempt to furnish applicants with more than a sufficient number of fish for a brood stock for a given body of water, and it expects these to be protected and allowed to reproduce.

SIZE OF FISH.

In its distribution of fish the bureau sends out certain species in the form of fingerlings or yearlings. This is especially true as regards brook and rainbow trouts. At certain stations, however, it is

necessary to distribute a portion of the product before this stage is reached in order to prevent overcrowding. The basses, bream, and other pond fishes are distributed from three weeks to several months after they are hatched. The last lots of bass shipped usually range from 4 to 6 and the sunfish from 2 to 4 inches in length. The commercial species, such as whitefish, trout, cod, pike. perch, etc., which are hatched in large numbers, are necessarily planted as fry. The basses, sunfishes, crappie, yellow perch, and other fishes rescued from the landlocked ponds and pools in the Mississippi Valley are from 3 to 6 inches in length when distributed. Eggs are distributed to State hatcheries and occasionally to applicants with the understanding that the resultant fry are to be planted in public waters.

PERIOD OF DISTRIBUTION.

Because of the increased cost of shipping fish, trips to distant points are postponed until there are a sufficient number of applications to warrant the expense. The bureau does not carry a stock of fish for delivery on demand, and when the supply of one year becomes exhausted it is necessary to wait until the next year's product is available to meet requests. The distribution of trout in the Eastern States is arranged early in March, and requests for trout submitted after March 1 are carried over until the following year. In the Rocky Mountain regions trout are distributed during the period extending from May to October, and applications should be filed with the bureau not later than May 1. Black bass, sunfish, crappie, etc., are supplied from May to November, and requests for those species should be filed prior to May 1, in order to receive attention before the following winter. It is the aim of the bureau to fill applications in the order of their receipt and to make delivery as soon thereafter as possible.

AERATION OF WATER.

When a large number of fish are confined in a receptacle, they soon consume the gaseous oxygen dissolved in the water, especially if the vessel is allowed to stand a while. It is important, therefore, that applicants receiving fish plant them as soon as possible. When the fish are carried in a vehicle, the splashing of the water serves to renew the supply of oxygen. This is true only when travel is over rough roads. Fish manifest their desire for oxygen by coming to the surface of the water. The water must be aerated, and a dipper should be provided for this purpose. Sufficient aeration may be accomplished by dipping the water and letting it fall from a height of about 2 feet, this process being repeated when the fish show signs of distress. *Fish should not be allowed to remain on the depot platforms, and, without expert knowledge in handling live fish, no attempt should be made to hold them overnight.*

Cool temperature is an important factor in holding fish, as the cooler the water the more gaseous oxygen it holds in solution. The proper temperature may be maintained by wrapping the containers in wet sacking or by placing ice in the cans.

PLANTING OF FISH.

When planting fish, sudden change in temperature should be avoided. This may be done by pouring some of the water from the cans and slowly adding water from the stream or lake in which the fish are to be deposited. The change of temperature should be gradual, not less than half an hour being consumed in modifying it 10°. In a stream it is best to deposit a few fish in each of several places as near as possible to the headwaters or in small tributaries. In lakes or ponds they should be scattered in shallow places where the water is not stagnant. Localities should be selected where the fish will have a supply of natural food and be immune from attacks of enemies.

COOPERATION WITH VARIOUS AGENCIES.

UNITED STATES FOREST SERVICE.

The major portion of fish distributed in Colorado, New Mexico, and Arizona is handled by forest rangers, who meet the consignments at railroad stations and carry the fish to the headwaters of streams. The method of keeping the headwaters of streams well stocked is productive of highly satisfactory results. The young fish are afforded suitable surroundings with abundance of natural food, they are free from the attacks of other fish, and they are, by virtue of the inaccessibility of the headwaters of many streams, out of reach of the angler. When the headwaters become overstocked, the large fish drop downstream in search of food, where they may be taken by anglers of the more populous districts. The idea of using the headwaters of streams as breeding and rearing grounds for the various species of trout is being followed wherever practicable. The plan possesses great possibilities and seems to be the only method whereby trout can be maintained in certain streams in view of the annual increase in the number of anglers.

NATIONAL PARKS.

Until within comparatively recent years the full possibilities of our national parks as fish preserves have not been given the serious consideration to which they are entitled. Realizing the necessity of maintaining a supply of fish in the waters of national parks, where fishing has become intensive during the open season, the bureau has established field stations in Yellowstone and Glacier Parks where skilled fish-culturists are temporarily detailed to make collections of and incubate the eggs of the various species of trout, the resultant fry being liberated in the waters most suitable for the particular species involved.

The National Park Service is now actively engaged in a most intensive campaign of fish-cultural development in cooperation with the bureau's hatcheries in Yellowstone and Glacier National Parks.

RAILROADS.

For a number of years the important railroads of the country have granted the bureau the privilege of carrying in baggage cars in passenger trains shipments of fish when accompanied by attendants,

the only requirements being that each attendant be provided with a first-class fare and the number of cans carried in a shipment be limited to 20. However, several railroads have recently volunteered free transportation for the bureau's distribution cars when engaged in planting fish in waters contiguous to their lines. The following extract from a letter received from the vice president and director of traffic of the Great Northern Railway is indicative of the attitude of one of the great railroad companies of the country toward this branch of the bureau's work:

ST. PAUL, MINN., *May 1, 1922.*

Mr. H. F. MOORE,
Acting Commissioner, Bureau of Fisheries, Washington, D. C.

DEAR SIR: We are very glad, indeed, to cooperate with your bureau in the development of fish culture in waters along our line. I am sure that the work done by your bureau is productive of much good at all points and is something that we feel should be encouraged. You may be assured in the future, as in the past, of our active cooperation at all times and thank you sincerely for writing me on the subject.

Yours very truly,

W. P. KENNEY.

The Oregon Short Line, Lehigh Valley, Pere Marquette, Michigan Central, Chicago, Milwaukee & St. Paul, Chicago & North Western, Chicago, Burlington & Quincy, Bangor & Aroostook, and the Maine Central are other railroads that have extended courtesies in the way of free transportation or reduced rates to the bureau's cars or to messengers in charge of living fish.

This cooperation demonstrates the value that the large railroad systems of the country place upon having the streams in the vicinity through which they pass well stocked with fish. Such streams not only afford pleasure for the tourist, but increase transportation over the roads and have a tendency to make such sections more attractive to settlers.

ORGANIZATIONS AND INDIVIDUALS.

Without the excellent spirit of cooperation shown by organizations and individuals and the valuable information received from anglers' clubs and others interested in fishing, the bureau, with its limited funds, could not undertake more than 75 per cent of the work it now accomplishes in interior waters. Although the bureau makes deliveries of fish at the railroad station of the applicant free of charge, the expense of hauling the consignment to suitable waters is no small item. This part of the cost is borne by the applicant, frequently an organization. Shipments of fish are sometimes met by 25 or 30 members of an organization and the consignment divided among them and planted in the waters most suitable for the particular species involved. These organizations are also of inestimable value in promoting sentiment for the enforcement of fisheries regulations and possibly serve to increase the supply of fish in streams by this more than by making plants of fish. The bureau desires to encourage the formation of such societies as will foster the supply of fish, and it is willing to render any advice that may be needed to attain that end. Applications for fish will be furnished such organizations when it is shown that the waters are in need of restocking.

FISH PROTECTION.

RESTRICTIVE FISHING LAWS ESSENTIAL.

It is obvious to everyone giving thought to the subject that unrestricted fishing, particularly in inland waters, can have but one result, namely, the complete disappearance of desirable fish. It is hardly probable that the most highly developed methods of artificial propagation, however intensively applied, can be made effective against the rapid growth of the country and the increasing numbers of anglers unless such work is supplemented by natural reproduction. This implies restrictive laws on fishing and the development of a public sentiment in favor of such laws and their enforcement. The following suggestions embody a few of the more important points for consideration in connection with fish protection. It is hardly possible to frame laws that can be applied generally. Each section of the country will find it necessary to modify the laws to meet existing local conditions.

As an earnest of good faith on his part—that he respects the fishing laws and intends to observe them—the prospective fisherman before starting on his trip should obtain from the State fisheries authorities a license to fish. If we are to protect any species of animals such protection must be extended to the young. Therefore a size limit on the fish that may be legally taken is unquestionably essential. If natural reproduction is to reach its highest value, fish must not be molested during their mating season. The true sportsman on his fishing trip is not seeking a large number of fish, but rather recreation in the open, and it is unsportsmanlike to take more fish at one time than can be properly used. This idea suggests the desirability of limiting the number of fish that may be legally taken in any one day. Angling is recognized as one of the most popular sports, but it is not sportsmanlike to take fish by other than sportsmanlike methods, which usually implies a rod and line held in the hand. The use of poisons or explosives and the shooting of fish are always reprehensible. The wanton obstruction of the free passage of fish in any stream, the deposit therein of trade or other industrial wastes injurious to fish, the operation of irrigation ditches without screening them for the exclusion of fish, all of these practices are prolific causes of unnecessary depletion of fish life in inland waters. In streams across which dams have been erected for industrial purposes fish will frequently congregate in considerable numbers at certain seasons of the year. To take them from such places by spearing, gaffing, or other means is obviously not sport but wanton destruction.

ENFORCEMENT OF FISHERIES LAWS.

The bureau has no jurisdiction in the enforcement of fisheries regulations excepting in Alaska and in respect to the sponge fisheries beyond State limits in the Gulf of Mexico, such matters coming under the State governments. If the fish and game laws are not enforced, the matter should be taken up with the proper officials of the State in which the violations occur. The bureau will not knowingly furnish fish for waters in which illegal fishing is unchecked. The matter of stream pollution and that of providing adequate fishways should also be taken up with the State fisheries authorities.

EXTERMINATION OF PREDATORY ANIMALS AT BUREAU'S STATIONS.[4]

Birds.—Traps placed on small platforms on stakes driven around the pond are used at a number of the bureau's stations for the capture of kingfishers, but these as well as the fish hawk, heron, fish duck, mud hen, water ouzel, and all other feathered enemies of fish life can be successfully held in check by the use of firearms.

Mink.—These animals may be taken either on land or in the water by means of a trap set on a projecting point of the bank, or in the water at places where the signs indicate that they come for fish. A mink will wander all along the banks of a stream or pond, exploring every nook, including all the little brooks and ditches emptying into it. The traps are therefore often set on fallen trees or logs across small streams. Bait is sometimes used. For this purpose the entrails of a bird or other animal are more satisfactory than the whole body, and a decayed fish is still better. Mink are believed to feed principally on fish.

Frogs.—There is some doubt as to whether frogs eat live fish and fish eggs. It is safe to say, however, that frogs under 1 year of age are not detrimental to fish. Frogs may be dipped from a pond by means of a net fastened to a long pole, or they may be killed by spearing.

Snakes.—Water snakes are perhaps the worst enemies of fish and should be killed by whatever method possible. Their depredations may be considerably lessened by keeping the ponds and streams clear of brush and débris.

Muskrats.—Trapping is the most practicable means of checking the inroads of muskrats, and if persisted in by a trapper of some skill their depredations may be stopped. For this purpose a No. 1 steel trap with a long chain of wire attached is the most suitable. It is usually best to set it half an inch to an inch under water, below the niches or shelves along the banks where the animals feed, as will be indicated by remains of roots and partially eaten stems of plants. The chain should be securely fastened to a stake driven as far out in the water as possible. When set in shallow water, the rat will be likely to twist off a leg and escape; but if deep water is accessible, it will try to escape by diving, and if there is plenty of chain it will soon drown. The trap may also be set under water in the trails or runways, on logs or boards sloping into the water, in burrows in the banks, or on the bottom of the pond at the entrance to a burrow, under the nest chambers of the houses. It is rarely necessary to bait the trap, though a slice of carrot or turnip will sometimes attract the animals. Where they are numerous a gun may be used at first, but they soon become timid and distrustful, making this impracticable. Poisoning appears not to have been resorted to in the case of muskrats, perhaps because of the attendant danger to other animals and because the dead rats pollute the water.

Turtles.—The most effective way of removing turtles from a pond or lake is to draw off the water and collect them in hand nets. If this is not practicable, a pole about the size of a telegraph pole may be placed slantwise in the water, at a point where the depth is from

[4] Advice given here is not to be taken as authority for killing animals protected by State laws.

4 to 6 feet, in such a position that its upper end projects about a foot above the surface. Stretch a net around the pole on all sides, except the one where the turtles would be most likely to crawl out of the water, adjusting it to form a pocket under the slanting end of the pole and fastening it with four or five stakes driven into the mud. A sudden approach in a boat will cause the turtles to drop off into the net, when they can be easily captured. Turtles, however, with the exception of the snapping turtle, are not considered very destructive of fish life. The latter can easily be captured by hook and line, baited with a piece of fish and secreted in the weeds where the fish can not find it.

Undesirable fishes.—Undesirable fishes that may gain entrance into a pond can be removed by hook-and-line fishing. Eels are caught in the same manner and also with special traps made like the old-fashioned lobster pot. In removing carp, if the conditions will permit, it is preferable to lower the water in the pond and use a seine. While this is being done the desirable fishes can be held in a retaining tank and returned to the pond after it is refilled.

RESULTS OF STOCKING INTERIOR WATERS.

During the period extending from 1899 to 1915, inclusive, 15,294 reports from applicants were recorded, the general results being as follows: Excellent, 1,581; good, 7,730; fair, 1,681; overflow, 428; uncertain, 916; and poor, 2,741. Eighteen per cent of the reports covering this period indicate poor results. This is attributable in a great measure to the early methods, necessarily experimental, of handling requests for fish.

Within recent years the bureau has developed a system of distribution by which the liability of making unsuitable assignments of fish is rendered remote. Many failures in the past have been due to placing black bass in small ponds. It is found from experience that this species will not produce satisfactory results in a body of water of less than 2 acres in area. Crappie, bream, and rock bass are now assigned for the smaller water areas, and it is evident from the reports received that such assignments are productive of very favorable results.

COMPARATIVE RESULTS FOR CERTAIN PERIODS.

The following table shows the comparative results of plants made during the periods from 1899 to 1915 and from 1916 to 1917. The improved method of handling requests for fish is believed to have been an important factor in the more successful results obtained in 1916 and 1917. Explanations, with comments, of terms used in this table and in the table below it follow.

Excellent means that the fish increased in size and multiplied. *Good* is used where the applicant was satisfied, the fish having attained a large size and the number apparently being on the increase. *Fair* means that the results were only ordinary, many of the applicants using this word merely to express the results of the plants. *Overflow* is used where the dam of the pond broke and the fish escaped. This does not mean a loss of the fish, as in many instances the statement is made that certain streams were stocked by the breaking of dams. *Uncertain* is used where the applicant is undecided as to the results. Most of the reports classified under this heading cover plants of fish made in

large streams and lakes where it was found difficult to determine whether the fish furnished by the bureau had actually produced results, owing to the fact that the waters had been previously stocked with the same species. *Poor* covers reports that indicate that the plants were a failure. Failures are attributed to a number of causes, as follows: Unsuitability of the waters, poor condition of the fish when received, destruction of the fish by snakes and other predatory animals. Many failures are attributed to the severe winter of 1916 and 1917, when ponds froze to an unprecedented depth. In some instances the fish were stolen.

Period.	Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1899–1915	10.5	51	11.5	3	6	18
1916–1917	30.6	42	12.5	2.2	6.2	6.5

DETAILED RESULTS FOR 1916 AND 1917.

The following table shows the detailed results of fish planting during the fiscal years 1916 and 1917, based on 4,589 reports received from individuals and organizations. This table does not cover shipments of fish made to agents of the United States Forestry Service. To economize space no tabular statement is presented for the period from 1899 to 1915. The preceding table, however, for the years 1916 and 1917 is fairly representative of the bureau's normal activities.

Results of fish planting during fiscal years 1916 and 1917, shown by States and species.

[For explanation of headings see p. 111.]

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Alabama:							
Catfish	4		2		2		
Rainbow trout	2		1			1	
Brook trout	1			1			
Crappie	8	2	3	2		1	
Large-mouthed black bass	94	35	36	7	6	6	4
Small-mouthed black bass	3		2				1
Rock bass	4	1	3				
Sunfish	90	15	37	16	10	4	8
Arizona:							
Catfish	5	1	4				
Rainbow trout	5		3			1	1
Black-spotted trout	2			2			
Brook trout	3	1	2				
Crappie	2		2				
Large-mouthed black bass	8	1	6		1		
Sunfish	1		1				
Arkansas:							
Catfish	9	5	2	2			
Rainbow trout	3	1	1	1			
Crappie	4	1	2		1		
Large-mouthed black bass	48	14	23	3	3	5	
Small-mouthed black bass	4	1		1		2	
Rock bass	8			3	1	1	3
Sunfish	21	5	3	4	2	2	5
California:							
Rainbow trout	2		2				
Large-mouthed black bass	1	1					
Sunfish	2	1				1	
Colorado:							
Catfish	2						2
Rainbow trout	42	12	27	3			
Black-spotted trout	164	36	113	14		1	

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Colorado—Continued.							
Lake trout	1	1					
Brook trout	87	12	52	19	1		3
Grayling	4	2	1			1	
Crappie	1		1				
Large-mouthed black bass	16	2	9	3			2
Rock bass	1		1				
Sunfish	3		3				
Connecticut:							
Steelhead salmon	1		1				
Brook trout	25	9	9	5		1	1
Large-mouthed black bass	8		6	1		1	
Small-mouthed black bass	2		1			1	
Sunfish	1		1				
Pike perch	2			1		1	
Yellow perch	1		1				
Delaware:							
Brook trout	2		1				1
Large-mouthed black bass	3		3				
Florida:							
Crappie	1						1
Large-mouthed black bass	26	2	19	2	1	1	1
Sunfish	1					1	
Georgia:							
Catfish	1						1
Rainbow trout	3		1	2			
Brook trout	1				1		
Crappie	6	1				3	2
Large-mouthed black bass	38	11	16	2	3	5	1
Small-mouthed black bass	1					1	
Rock bass	1			1			
Sunfish	17	3	5	3	3	1	2
Idaho:							
Rainbow trout	6		2		1	1	2
Black-spotted trout	3	2	1				
Brook trout	3		2				1
Grayling	1	1					
Illinois:							
Brook trout	1						1
Crappie	15	2	7	4	1		1
Large-mouthed black bass	9	4	2	1		1	1
Small-mouthed black bass	5	1	2	1		1	
Rock bass	3	2	1				
Sunfish	1				1		
Pike perch	1	1					
Indiana:							
Catfish	5	1	3	1			
Rainbow trout	3		1	1		1	
Brook trout	1					1	
Crappie	9	2	4	1		1	1
Large-mouthed black bass	38	8	21	3	3	2	1
Small-mouthed black bass	29	5	19	1	1	1	2
Rock bass	13	2	2	3		4	2
Sunfish	10	1	3	3	1	2	
Pike perch	7	1	3	1		1	1
Iowa:							
Catfish	2	1					1
Rainbow trout	2	1		1			
Crappie	3		2	1			
Large-mouthed black bass	5	1	3			1	
Sunfish	2				2		
Pike perch	1				1		
Kansas:							
Crappie	1		1				
Large-mouthed black bass	10	6		3			1
Kentucky:							
Catfish	1	1					
Rainbow trout	1		1				
Crappie	18	2	7	3	1	1	4
Large-mouthed black bass	61	11	29	9	1	7	4
Small-mouthed black bass	12	2	2	4		1	3
Rock bass	13	2	6	2		1	2
Sunfish	7	2	1	1	1	1	1
Louisiana:							
Catfish	1		1				
Crappie	8		2	2	2	2	
Large-mouthed black bass	8	2	5	1			
Sunfish	4		3				1

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Maine:							
Steelhead salmon	2					2	
Landlocked salmon	9	1	6	2			
Lake trout	1		1				
Brook trout	39	11	25	1		2	
White perch	3		1			2	
Maryland:							
Catfish	1		1				
Rainbow trout	5	3	1			1	
Brook trout	12		10	2			
Large-mouthed black bass	18	1	9	4		3	1
Small-mouthed black bass	2		2				
Massachusetts:							
Catfish	2	1	1				
Landlocked salmon	3		2				1
Rainbow trout	2					1	1
Brook trout	27	11	12	3		1	
White perch	2			1		1	
Minnesota:							
Rainbow trout	8	4	2		1	1	
Lake trout	2		2				
Brook trout	11	4	4			2	1
Crappie	2		2				
Pike perch	5	3		1		1	
Michigan:							
Catfish	12	2	5	4		1	
Steelhead salmon	7	1	4			2	
Rainbow trout	10	3	4			2	1
Lake trout	2					1	1
Brook trout	62	24	27	3	1	5	2
Grayling	1			1			
Crappie	9	2	4	1		2	
Large-mouthed black bass	56	21	33	1		1	
Small-mouthed black bass	129	47	57	4	2	9	10
Rock bass	1	1					
Sunfish	8	5	1	1		1	
Pike perch	13	8		1		3	1
Yellow perch	4		2	1		1	
Mississippi:							
Catfish	5	1	3	1			
Buffalo fish	1		1				
Crappie	47	21	11	7	2	3	3
Large-mouthed black bass	54	26	14	5	3		6
Sunfish	17	5	5	4	1	1	1
Missouri:							
Catfish	12	2	1	7		1	1
Buffalo fish	1	1					
Rainbow trout	24	11	5	3		3	2
Crappie	32	14	5	10		2	1
Large-mouthed black bass	64	34	18	10			2
Small-mouthed black bass	7	2	2			2	1
Rock bass	4	3	1				
Sunfish	24	6	6	8		1	3
Pike perch	3	3					
Yellow perch	3	1		1			1
Montana:							
Catfish	4	3				1	
Steelhead salmon	2					1	1
Rainbow trout	78	18	24	29		4	3
Black-spotted trout	100	53	29	9		5	4
Brown trout	1	1					
Brook trout	119	34	63	17		3	2
Grayling	3	2	1				
Rock bass	1			1			
Sunfish	3	1		2			
Yellow perch	1	1					
Nebraska:							
Catfish	1			1			
Rainbow trout	9	6	2	1			
Brook trout	17	5	8	4			
Crappie	4			2			2
Large-mouthed black bass	4	2	1				1
Sunfish	1			1			
New Hampshire:							
Catfish	3	1	1			1	
Steelhead salmon	1					1	
Landlocked salmon	8	3	3	1		1	
Rainbow trout	20	5	3	4		3	5

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
New Hampshire—Continued.							
Lake trout	6	1	2			1	2
Brook trout	150	79	58	6		4	3
Crappie	1			1			
Large-mouthed black bass	3	3					
Small-mouthed black bass	1			1			
Yellow perch	2	1				1	
White perch	3		1			1	1
New Jersey:							
Rainbow trout	1			1			
Brook trout	10	3	5	1			
Large-mouthed black bass	13	4	6	1			2
Small-mouthed black bass	10	7	1			2	
Rock bass	1	1					
Sunfish	1						1
Yellow perch	1	1					
New Mexico:							
Catfish	4	1	2				1
Rainbow trout	3	2	1				
Black-spotted trout	4	2	2				
Brook trout	2	2					
Large-mouthed black bass	11	4	4	2		1	
Sunfish	8	1	2	2		1	2
Yellow perch	2		1			1	
New York:							
Catfish	4	2	2				
Steelhead salmon	1		1				
Landlocked salmon	4	1	3				
Rainbow trout	11	4	3			4	
Lake trout	5	1	2	2			
Brook trout	62	35	17	5		3	2
Crappie	3			2		1	
Large-mouthed black bass	21	9	9	2		1	
Small-mouthed black bass	15	2	4	6	1	2	
Rock bass	4		1	1	1	1	
Sunfish	6	2	1				3
Pike perch	21	7	7	1		3	3
Yellow perch	2	1					1
White perch	2					2	
North Carolina:							
Rainbow trout	15	3	6	1	3	1	1
Brook trout	9	2	5		1	1	
Crapple	2	2					
Large-mouthed black bass	26	5	6	8	6	1	
Rock bass	3			2		1	
Sunfish	5		1		1		3
North Dakota:							
Catfish	2			1		1	
Rainbow trout	1						1
Crappie	5	1	2			1	1
Large-mouthed black bass	9	1	3	3			2
Rock bass	1			1			
Pike perch	1			1			
Yellow perch	1						1
Ohio:							
Catfish	4	1		1		1	1
Rainbow trout	9	3	1	1		2	2
Brook trout	1						1
Crappie	9		1	6		1	1
Large-mouthed black bass	28	5	17	6			
Small-mouthed black bass	22	6	3	11		2	
Rock bass	2		2				
Sunfish	5	2	1	2			
Pike perch	3		2			1	
Yellow perch	3	2					1
Oklahoma:							
Catfish	1	1					
Crappie	10	2	4	1	1	1	1
Large-mouthed black bass	18	5	11		1		1
Rock bass	4			1	1	1	1
Sunfish	8	2		2	2		2
Pennsylvania:							
Catfish	33	9	13	6		1	4
Rainbow trout	181	55	69	19		16	22
Brook trout	532	189	221	43		18	61
Crappie	6	2	2			1	1
Large-mouthed black bass	96	31	45	10		5	5
Small-mouthed black bass	72	27	29	11		4	1

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Pennsylvania—Continued.							
Rock bass	7	2	2	2			1
Sunfish	25	5	14	3	1	2	
Pike perch	14	9	1	3			1
Yellow perch	5	1	2	1			1
Rhode Island: Brook trout	1		1				
South Carolina:							
Catfish	3	1	1	1			
Rainbow trout	4	2	1	1			
Brook trout	1	1					
Crappie	2			1			1
Large-mouthed black bass	39	4	16	8	4	3	4
Sunfish	6			5			1
South Dakota:							
Catfish	3		3				
Steelhead salmon	1					1	
Rainbow trout	16	1	12	2		1	
Black-spotted trout	11	5	5		1		
Loch Leven trout	6	2	3			1	
Brook trout	27	6	18	2	1		
Crappie	4		2	1		1	
Large-mouthed black bass	5	2	1	1		1	
Pike perch	1			1			
Tennessee:							
Rainbow trout	15	2	6	4		1	2
Brook trout	3	1	1	1			
Crappie	5		5				
Large-mouthed black bass	18	4	9	3			2
Small-mouthed black bass	1		1				
Vermont:							
Steelhead salmon	4	2		2			
Landlocked salmon	4	3	1				
Rainbow trout	2		2				
Lake trout	2		2				
Brook trout	156	62	83	2		2	7
Large-mouthed black bass	4		1	2			1
Small-mouthed black bass	7	1	4			1	1
Pike perch	16	7	3	1		3	2
Yellow perch	6	2	2			1	1
White perch	1					1	
Virginia:							
Catfish	2		2				
Rainbow trout	54	3	21	15	2	5	8
Brook trout	9	2	3	3			1
Crappie	7	1	3	2			1
Large-mouthed black bass	23	1	8	7		4	3
Small-mouthed black bass	4		2	1	1		
Rock bass	5		2	2	1		
Sunfish	2			2			
Yellow perch	1						1
Washington:							
Rainbow trout	6	3	1	1		1	
Black-spotted trout	1	1					
Brook trout	2	1	1				
West Virginia:							
Catfish	1					1	
Rainbow trout	7	2	4	1			
Brook trout	9	7	2				
Crappie	2	1	1				
Large-mouthed black bass	7	1	4	1		1	
Wisconsin:							
Steelhead salmon	1					1	
Rainbow trout	37	9	19	7		1	1
Lake trout	2	1				1	
Brook trout	127	30	86	6	1	2	2
Crappie	9	1	3	4	1		
Large-mouthed black bass	36	10	23			2	1
Sunfish	1	1					
Pike perch	9	4	3			1	1
Wyoming:							
Rainbow trout	2	2					
Black-spotted trout	3	2	1				
Brook trout	2	1	1				
Large-mouthed black bass	1	1					
Total	4,589	1,400	1,938	574	92	278	307

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